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OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT

HARVARD COLLEGE.

VOL. II.

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ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

Published by order of the Legislature of Massachusetts.

No. III.

MONOGRAPH OF THE NORTH AMERICAN ASTACIDÆ.

BY

DR. HERMANN A. HAGEN.

CAMBRIDGE:
FOR SALE BY SEVER AND FRANCIS.
1870.

University Press: Welch, Bigelow, & Co.,
Cambridge.

NOTE.

It is but justice to Dr. Hagen to state that this monograph was completed by him and handed to me for publication as early as October, 1868. Circumstances over which I had no control have delayed its passage through the press till now.

LOUIS AGASSIZ.

Cambridge, February 21, 1870.

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CAMBARUS. GROUP I.

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CAMBARUS. GROUP II.

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CAMBARUS. GROUP III.

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ASTACUS.

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Cambarus Clarkii, Male Form I. (nat. size).

Plate V.

Cambarus affinis, Fem. (nat. size).

Plate VI.

Cambarus pellucidus, Male Form I. (nat. size).

Plate VII.

Cambarus advena, Male Form I. (twice enlarged).

Plate VIII.

Cambarus virilis, Male Form I. (nat. size); a hand of var. A. *Cambarus immunis*, hand.

Plate IX.

Cambarus obesus, Male Form I. (nat. size).

Plate X.

Astacus Trowbridgii, Fem. Type (nat. size).

Plate XI.

Astacus Gambelii, Male. Type (nat. size).

INTRODUCTION.

THE following monograph of the Fresh-water Crawfishes of North America is intended to form the first step in a scientific examination of the rich crustacean materials contained in the Museum of Comparative Zoölogy at Harvard College, in Cambridge. The excellent monograph of the genus Callinectes, published by Mr. A. Ordway in 1863, is the only work about Crustacea, based principally upon the Cambridge collection.

Arriving in Cambridge in October, 1867, in order to take care of the articulated animals belonging to the Museum, I was charged first to arrange and put in order the Crustacea. Because of the almost total lack of room and of working hands (the rich collections from Brazil procured by the Thayer Expedition having occupied all working time for the last two years), but a small part had been as yet determined and arranged in the rooms opened for public exhibition. The greater portion of them had been stored for several years in the cellar, and therefore was so situated as not to be readily accessible for a scientific examination.

The part exhibited comprised a series of three hundred and twenty-seven determined species in a systematical collection, also three hundred and thirty-seven determined species in several faunal collections, and a few types of the United States Exploring Expedition. Nearly all the latter species being represented also in the systematical series, the number of named species (determined mostly by Mr. Dana and Mr. W. Stimpson) did not perhaps exceed five hundred. With the exception of several boxes already separated, with duplicates for exchange, they answered to a catalogue of nearly sixteen hundred numbers, containing the names of the respective localities and collectors, the dates of capture, and, in some cases, the scientific determinations by Mr. W. Stimpson.

The whole collection is now in a safe condition, mostly unpacked and arranged in new alcohol. The division of the entire assemblage has been carried as far as the families, that of the greater part as far as the genera, while several families have been critically identified. There are over four thousand two hundred jars. The number of specimens, perhaps, exceeds sixty thousand; the additions during the years 1863–1866 were fourteen thousand specimens. According to Professor L. Agassiz's estimate, the collection comprises more than two thousand species, the entire number of species as yet known being about five thousand. A closer examination of several families verifies this estimate, or rather indicates that it is probably too small. Nearly one half of the collection is formed by the Brachyura, one fourth by the Macroura.

The value of the collection is the greater from the circumstance that most of it has been secured and formed, in view of a definite plan adopted by Professor L. Agassiz for the purpose of examining and defining the different faunæ in the gigantic water-area spreading between the coast of Eastern Africa and Western America. Several persons have been charged with the collecting of the fishes, the crustacea, and the polyps at chosen points, — at Zanzibar, Mr. C. Cooke; at Kingsmills, Sandwich and Society Islands, Mr. Garrett; on the West Coast of America, Messrs. A. Agassiz, and T. G. Cary. At the same time rich collections have been received from additional intermediate localities, — Rangoon, Singapore, China, New Holland, and others, chiefly through Captain W. A. Putnam. The Museum is also very rich in specimens from the shores of the United States, from the Antilles, and from Brazil; it likewise possesses valuable materials from the European and Mediterranean fauna.

The materials examined by me for this monograph of the North American Astacidæ are, I think, as yet unrivalled. They consist of the following assemblages: 1. The Astacidæ of the Cambridge Museum, twenty-five species, represented by nearly two thousand alcoholic specimens from one hundred and fifty different collectors and as many different localities, besides some dry specimens, partly types of Dr. Gibbes. 2. The Astacidæ of the Museum of the Philadelphia Academy, kindly communicated to me by Professor Leidy, containing types of Messrs. John LeConte and Girard. 3. The Astacidæ of the Museum of the Natural History Society in Boston, containing types of Professor W. Stimpson. 4. The Astacidæ of the Museum of the Peabody Academy in Salem, which, with the last, were kindly communicated to me by Dr.

A. S. Packard. 5. Types of nine species of Mr. Girard and Professor W. Stimpson, kindly communicated to me by Professor W. Stimpson.

The Astacidæ in the collection of the Smithsonian Institution I have not yet seen.

I have described thirty-eight species, — thirty-two Cambari and six Astaci. Eleven species, all Cambari, are new. There are six species — four Cambari and two Astaci — which I have not seen.

Among the twenty-eight species of Cambarus which I have examined I have seen the two forms of the male, and the female of twenty-three species, the first form of the male and the female of one species. There are two species, of which I have seen only the first form of the male; of one species I have seen only the second form; of five species I have seen but single specimens; of all others, a considerable number.

Among the four species of Astacus which I have examined I have seen of one species both the male and female; of another species, the male only; of the other two species, the female only; and in all cases only a few specimens of each species.

This monograph, as I am convinced, is very far from embracing the entire number of species living in North America. May new explorations soon render my work incomplete.

HISTORY OF THE AMERICAN ASTACIDÆ.

1798. The first North American species made known was described by Fabricius, in his *Supplementum Entomologiæ Systematicæ*. It was called *Astacus Bartonii*, and communicated by Professor Smith Barton. The description is very short, and the locality not given, but it is probably the species more recently determined as *A. Bartonii* by American naturalists. Bosc, Hist. Nat. des Crust., Suites à Buffon an x. (1802), describes in few words, repeated by Latreille, Hist. Nat. des Crust., VI. 240, *Astacus Bartonii*, which he collected in America. The figure given by him is very bad, and it is impossible to identify his species.

1817. Rafinesque, in the American Monthly Magazine, II. 42, November, describes four species, — *Astacus limosus*, *fossor*, *ciliaris*, and *pusillus*. His descriptions are likewise very short, but the locality is given, and it will therefore be possible to determine them exactly by further investigations.

A. limosus is perhaps *A. affinis* Say, and *A. fossor* the species described by me as *A. obscurus*, if it has burrowing habits. *A. ciliaris* is apparently *A. Bartonii*, but the dimensions given by Rafinesque are, as for the foregoing species, excessive. The ciliated legs do not belong exclusively to this species. I think *A. pusillus* does not differ from *A. ciliaris*. The differences given are not important, — "the rostrum oval acute," "the hands oblong, dotted," "entirely fulvous brown"; in *A. ciliaris*, "the rostrum short, acute," "the hands short, thick dotted," "entirely olivaceous brown." Perhaps *A. pusillus* is the second form of the male; still, ciliæ always occur on its second pair of legs, and Rafinesque would have mentioned the fact in this instance no less than in *A. ciliaris*.

One month after the appearance of the account of Rafinesque, Th. Say, in Journ. Acad. Phil., I. Part I. 167, December, described two species, — *A. Bartonii* and *affinis*. His descriptions are good, and sufficient to designate the species. A supplement is given, l. c. 443, concerning the variation of their armature and the proportion of the hands in *A. Bartonii*; but here perhaps Mr. Say speaks of a different species. *Astacus Bartonii* Say is probably the species described by Fabricius, and *Astacus affinis* seems to be *Astacus limosus* Rafinesque.

The better description authorizes us to prefer a name published one month later.

1830. R. Harlan, in Trans. Amer. Philos. Soc. Phila. III. 464, gives the description of *Astacus Blandingii* from South Carolina, repeated in 1835 in his Medic. and Phys. Research. 229, with the addition of short specific characters of *Astacus Bartonii* and *affinis*, and the figures of the three species. But the numbers of two species are erroneously changed in the drawings. The specimen types preserved in the collection of the Philadelphia Academy have been kindly communicated to me by Professor Leidy.

1833. John D. Godman, in Rambles of a Naturalist, Philadelphia, pp. 40, 41, has communicated his observations upon the burrowing habits of *Cambarus Diogenes*. I have not seen this work, which is quoted by Mr. Ch. Girard.

1837. Professor Milne-Edwards, of Paris, in his Hist. Nat. des Crust., II. 331, describes *Astacus Bartonii*, *affinis*, and *Chilensis*. The change of the numbers in Harlan's figures has apparently induced him to reverse the names of the two species.

1839. Mr. J. W. Randall, Journ. Acad. Phila., VIII., Part I. 138, describes *Astacus Oreganus* from the Columbia River, figured in pl. 7. The description is very short and the figure apparently very erroneous. The type was lost by the artist, and it is still impossible to identify the species.

1842. De Haan, in Faun. Japonic. Crust., 164, has observed the interesting fact that *Astacus Bartonii* and *A. affinis* possess one gill less than *A. fluviatilis* and *Japonicus*. The gill on the fifth pair of legs is wanting.

Professor Z. Thompson, in his Natural History of Vermont, 170, notes the occurrence of *Astacus Bartonii* in that State.

1844. In J. Mueller, Archiv. 383, Dr. Tellkampf describes the remarkable blind species from the Mammoth Cave in Kentucky, *A. pellucidus*.

James E. De Kay, in his Zoölogy of New York, Part VI., Crustacea, 22, gives the description and figure (pl. 8, fig. 25) of *Astacus Bartonii*, and the diagnoses of *A. affinis*, *Blandingii*, and *Oreganus*.

1845. I. E. Gray published in Journals of Exped. of Discovery in Central Australia, by E. J. Eyre, a paper on some *Astaci* from New Holland, in which he suggests that the genus *Astacus* may be divided into three sections, characterized by the texture of the caudal segment, in being calcareous or not to its top. Mr. James D. Dana has proved that this character cannot be of much value in classification.

1846. Erichson, in Wiegmann's Archiv. Jahrg., XII. 86, and supplement, 375, gives an elaborate monograph of the whole genus *Astacus*. He describes from America, *Astacus pellucidus, affinis, Carolinus, Bar-*

tonii, *Blandingii* (after Harlan's description and figure), *Wiegmanni*, *Mexicanus*, *Cubensis*, *Chilensis* (after M. Edwards's description), and *Oreganus* (after Randall's description and figure). His materials were few; of *A. pellucidus* and *affinis* he saw but one specimen, but his descriptions are largely comparative. The observation first made by De Haan, that the American species possess no gills at the base of the fifth pair of legs, is repeated and verified in the other species described by Erichson, and taken for the formation of a particular subgenus, *Cambarus*. Erichson's monograph is still unrivalled, comprising all the species of the whole world. Still, there is no certainty in the determination of the species which he described, since so many similar species have been more recently found. But it is possible to arrange them in my groups, as Erichson has noted the number of hooked legs of the males. His types are preserved in the Berlin Museum, and an examination of them will prove, perhaps, that in the case of some species my determinations are erroneous.

1850. Mr. Lewis R. Gibbes, in his work "On the Carcinol. Collect. in the U. S.," 31, quoted *Astacus Bartonii*, *affinis*, *Blandingii*, and *pellucidus*. But the localities given by him are doubtful, as I have seen very different species presented by him, under the same name, to the Philadelphia and the Cambridge Museums.

1854. The richness of the materials preserved at the Smithsonian Institution in Washington, and chiefly collected by Professor S. F. Baird, led Mr. Ch. Girard to examine them critically in "A Revision of the North American *Astaci*, with Observations on their Habits and Geographical Distribution," Proc. Acad. Phil., VI. 87, and to characterize them briefly, deferring to another opportunity more full descriptions, accompanied by the necessary illustrations. Mr. Girard enumerates twenty species, eleven of which are new. Two, *C. Oreganus* and *fossor*, he had not seen. Professor Stimpson has kindly communicated to me the types of five of the eleven new species, namely, *C. Clarkii*, *propinquus*, *montanus*, *rusticus*, *longulus*, and the types of two species described before, namely, *A. Bartonii* and *affinis*. The Museum of the Philadelphia Academy possesses also some species labelled with Mr. Girard's names, which were kindly communicated to me by Professor Leidy. I do not know whether these specimens are types, since some are marked with a ?; but as they are mostly from the localities quoted by M. Girard, their identity is probable. These species are: *C. Pealei?* from the Potomac, *C. rusticus?*, *C. montanus?*, *C. Diogenes?* from the District of Columbia, *C. acutissimus* from Kemper County, Missouri, *C. Blandingii* from South Carolina, *C. robustus* from the Humber River at Toronto, *C. propinquus?* from Garrison Creek, Sackett's Harbor, *C. montanus?* from the James River, Virginia. Also, of the twenty species enumerated by Mr. Ch. Girard I have certainly not seen his types of

the five following: *C. pellucidus*, *Carolinus*, *pusillus*, *Nebrascensis*, *acutus*, nor the two species which he had not seen himself, *C. Oreganus* and *fossor*.

Mr. Ch. Girard has adopted the generic name *Cambarus* Erichson for the American species described by him. The introduction to Mr. Ch. Girard's Revision, etc., "according to recent investigations (Erichson is here quoted alone), the crawfishes, or *Astaci*, have been distributed into several genera," does not agree at all with Erichson's words. Erichson, in his monograph, p. 86, in dividing the old genus *Astacus*, expressly says: "The five groups quoted seem to have a higher value than merely subdivisions. Perhaps hereafter they will constitute genera. They may provisionally be regarded as subgenera." Mr. Girard added that Mr. James D. Dana had reclaimed the genus *Astacus* for North America by a species from the Columbia River, — *A. leniusculus*. Subsequently, Proc. Acad. Phil., VI. 375, Professor Agassiz stated that *C. Gambelii*, described as *Cambarus* by Mr. Ch. Girard, possesses six pairs of gills like the crawfishes of Europe, and does not belong to *Cambarus* at all. This statement is the more striking, as Erichson only gives as the character of *Cambarus*, "no gills on the fifth legs." The reply of Mr. Ch. Girard, l. c., p. 381, that he was not satisfied that this peculiarity is of generic value, and consequently that he described *C. Gambelii* as *Cambarus* with the same propriety as he might have placed it in the genus *Astacus*, gives no more light upon the characters of generic value which induced Mr. Ch. Girard to separate *Cambarus* as a distinct genus. In his Revision, etc., nothing more is said concerning this point, and he has not given any other character for his genus *Cambarus*, including *C. Gambelii* and *Oreganus*.

It is to be regretted that Mr. Ch. Girard has not fulfilled his plan of giving more full descriptions, accompanied with the necessary graphic illustrations. His short descriptions are not sufficient to indicate his new species with certainty, and for the species previously published the synonymy alone is given, for which reasons it is impossible to prove that his determinations are unquestionable. It is to be acknowledged as a fact of value, that Mr. Ch. Girard first used in his descriptions the specifically different shape of the first pair of abdominal legs in the male, and the different breadth of the dorsal area.

He has divided the species into three groups, with the following characteristics: I. Rostrum subquadrangularly elongated, terminated anteriorly by three conical and acute spines, the two lateral smaller than the middle one, which forms the tip. Extremity of the anterior pair of abdominal legs in the male straight and acute. (7 spec.) II. Rostrum generally broad, conical, and short, with margins entire and toothless, terminated anteriorly by an acute and comparatively short point. Anterior pair of abdominal legs in the male recurved at their extremity.

the tip of which is rounded. (9 spec.) III. Rostrum very much elongated, conical, tapering, provided on both sides and rather near the extremity with a small and acute spine, sometimes, however, but very slightly developed. (4 spec.)

Concerning the species described by Mr. Ch. Girard, — I have given my opinion at some length in my descriptions, — I may here make the following remarks: *C. Pealei* I consider as a full-grown *C. affinis; C. montanus*, *Diogenes*, and *pusillus* I am not able to separate from *C. Bartonii;* and *C. longulus* is possibly an abnormal specimen of the same species. *C. Blandingii* is not the species described by Harlan, but is *C. troglodytes*, Le Conte. *C. acutissimus* is the second form of the male of *C. acutus*. Some of my determinations may be incorrect; I hope hereafter to be able to compare the typical specimens preserved in the collection of the Smithsonian Institution.

The description and the detailed account of the burrowing habits of *C. Diogenes* given by Mr. Ch. Girard are very interesting, and, so far as I know, they are still the most complete description of this peculiar manner of living. Besides the remarks by Mr. John D. Godman, which I have not seen, Professor Erichson has mentioned the burrowing habits of some Australian species, and in the last edition of Cuvier's "Regnè Animal," the burrowing habits of an American species which severely damages the rice-fields of the Southern States are quoted from a communication by Dr. John Le Conte.

1855. Dr. John Le Conte has given, in the Proc. Acad. Phila., VII. 400, "Descriptions of new Species of *Astacus* from Georgia." Of the species described by Mr. Ch. Girard all but one are from the South, the others are from the Northern, and mostly from the Eastern States. Therefore Dr. John Le Conte's monograph is far more interesting. He describes nine species from Georgia, eight new; and there are two more, only seen by him. He remarks that he has preferred the old generic name *Astacus*, because the very slight and not very apparent differences which has been adopted to distinguish these two genera appear to him of little moment. Their color, says Dr. John Le Conte, is generally lost with their life, so that it is of little value in the description. "All that I have ever seen were much of the same color, — a reddish brown, inclining to dark olive." I do not find that any marks can be definitely pointed out by which we can distinguish those which are subterranean from those which are aquatic. It is possible to determine the species by the elaborate descriptions, especially by the shape of the rostrum and the hands, and the breadth of the areola. The types of six species, contained in the Museum of the Philadelphia Academy, have been kindly communicated to me by Professor Leidy, viz. *A. troglodytes, spiculifer, fossarum, angustatus, latimanus, advena.*

Concerning his species, I would remark that *A. troglodytes* is sy-

nonymous with *C. Blandingii* Girard, and that from this species I am not able to separate *A. fossarum*. But having seen only one female type, the identity must be proved by further investigation. *A. Blandingii* Le Conte is identical with *C. Leeontei* Hagen, or perhaps with Harlan's species. *A. spiculifer* is without doubt a new and good species, but I am not able to separate it decisively from the type *A. angustatus*. *A. latimanus* and *advena* are new species; *A. maniculatus* is entirely unknown to me.

After these reductions, we find the number of different species in the United States to be twenty, — fifteen given by Mr. Ch. Girard and five by Dr. John Le Conte.

1852. Professor James D. Dana, in his Synopsis Familiarum Crustaceorum, in the Proc. Acad. Phila., VI. 15, divided the old genus *Astacus* into two genera, *Astacoides* (segmentum abdominis maris primum appendicibus carens) and *Astacus* (segmentum abdominis maris primum appendicibus instructum). With *Astacoides* are united *Engæus* and *Cheraps*, with *Astacus Cambarus*. He describes (p. 20) *Astacus leniusculus* from the Columbia River "pedesquinti branchias parvas gerentes." In his celebrated work, United States Expl. Exped., Crustacea, I. 522, he says: "Among the distinctions subdividing the genus *Astacus*, that of the presence or absence of prehensile appendages to the first abdominal segments in males, fitted for use in coition, appears to be of the first importance. But the texture of the caudal segment, whether calcareous or not to its tip, cannot be of much value in classification, for it varies in the same species with age, and must therefore be somewhat dependent on the size of the species. The presence of a branchia to the posterior pair of legs may prove to be a characteristic of importance, requiring a subdivision accordingly; but of this we doubt. In the American species without this branchia, which the author has examined, the medial posterodorsal region of the carapax is narrow linear, while in the European species and that from Oregon, having the full number of branchiæ, this region is quite broad. But we cannot say how far this is generally true. For the reasons stated, we accept of *Astacoides* as a distinct genus, separated from *Astacus* by the absence of appendages from the first segment of the abdomen, and we unite with it *Cheraps* and *Engæus* of Erichson. The occurrence of the *Engæi* in holes in moist earth is not peculiar to that group, for the same habit has been observed by Professor S. F. Baird in an American species. *Cheraps* may perhaps be retained as a subgenus under *Astacoides*, on account of the absence of the posterior branchiæ; and, on the same ground, and no other of importance, *Cambarus* may be retained as a subgenus under *Astacus*." For this reason the author has retained *Cambarus* as a subgenus under *Astacus*, in his Synopsis, I. 523, and in the revision and emendation, II. 1433.

Astacus leniusculus is described, p. 524, and figured, pl. 33, fig. 1. I have never seen this species. *Astacus Bartonii*, locality uncertain, possibly from Brazil, is described, p. 525, and figured, pl. 33, fig. 2. The figure differs from all *C. Bartonii* which I have seen, even from the types communicated by Professor Stimpson and Professor Leidy. The rostrum, the antennal lamina, the areola, and the hand are so different in shape that evidently there must be a mistake. The patria, "possibly from Brazil," is another stumbling-block. In the Museum of the Philadelphia Academy are two Astaci labelled Potamobius spec. West Indies, and one labelled Bahia. But all three are undoubtedly the European *Astacus fluviatilis*. Perhaps the labels have been changed. Another small specimen, labelled Brazil, agrees in the shape of the rostrum with the figure given by Dana, but this curious species is neither an *Astacus* nor a *Cambarus*, but perhaps a *Cheraps*. It is a male, without the first pair of abdominal legs. Astacidæ must be very rare in Brazil, as it was impossible for Professor Agassiz and the members of the Thayer Expedition to obtain any specimen, or even to ascertain the existence of any *Astacus* species, in the vast country investigated by them. It must be remarked that Erichson has never seen the *Astacus Chilensis* mentioned by him; perhaps it is not a *Cambarus* at all.

1857. Professor W. Stimpson, in "The Crustacea and Echinodermata of the Pacific Shores of North America," Journ. Boston Soc. N. H., VI. (and separate, Cambridge, 1857–58, p. 93, pl. 6), gives detailed descriptions of three new species, — *A. nigrescens*, from San Francisco; *A. Trowbridgii*, from Astoria, and *A. Klamathensis*, from the Klamath Lake. Also shorter notices of *A. Gambelii*, *A. leniusculus*, and *A. Oreganus*. He has kindly communicated to me the types of the new species. They are apparently a very valuable addition to the North American fauna, as is also the negative fact that as yet not a single species of *Cambarus* has been found in the States of the Pacific shores.

1866. Spence C. Bate, in "Vancouver Island Crabs," in the Naturalist in Vancouver's Island and British Columbia, by J. Keast Lord, London, II. 278, says that *A. Klamathensis* is to be found in all streams east of the Cascades.

1864. Mr. H. Lucas has given a Note on *Astacus pellucidus*, which I have not seen, in the Bullet. Soc. Entom. Paris, p. iv.

1857. Mr. H. de Saussure, in Geneva, describes in his "Note carcinologique zur la famille des Thalassides et sur celle des Astacides," Rev. et Magas. de Zoologie, IX. pp. 99–102 et 503, three new species of *Cambarus* from America, *C. consobrinus* from Cuba, *C. Montezumæ* and *C. Aztecus*, both from Mexico. The descriptions are too short for a certain judgment, especially as I have not seen any species from Cuba, and but one female from Mexico. It is impossible, from the descriptions alone, to separate *C. consobrinus* from *C. Cubensis*, and the two other species from *C. Mexicanus*.

1858. Mr. H. de Saussure, in Mém. de la Soc. Phys. de Genève, T. 14, Pars II., pp. 456–461, Tab. III. f. 21–23, gives detailed descriptions and figures of the three before-mentioned species. His remark, that the *Cambarus* prefer the marshes and muddy waters, is apparently not of general value. Many species of *Cambarus*, perhaps the greater part, live in pure running water; for some species it is directly stated by Dr. LeConte.

I find it impossible to separate the species described by Mr. De Saussure from the species described by Mr. Erichson, but a judgment from two descriptions (I have seen only one female) is always doubtful. I am not sure that the hooked legs described by Mr. De Saussure correspond with those of Mr. Erichson. I think Mr. De Saussure's second and third pairs of legs are the third and the fourth of Erichson, the latter commencing the numbering of the legs with the great claws, Mr. De Saussure beginning with the pair next after the great claws. I think the words in the Note by *C. Montezumæ*, "son *C. Mexicanus* en est bien distinct par le troisième article inerme de la *quatrième* paire des pattes," is otherwise not intelligible. In *C. consobrinus* the second joint of the legs is said to be hooked; if this be not a typographic error, it is a strange exception.

C. consobrinus is not at all compared with *C. Cubensis* Erichs.; perhaps it is unknown to Mr. De Saussure. The two descriptions show no difference. The lamina of the antennæ, f. 21, b., has no apical external spine, — perhaps an error.

C. Montezumæ does not differ from *C. Mexicanus*, and *C. Aztecus* seems identical with *C. Wagnanni*. But I confess that my materials are too imperfect to decide this question.

ON THE CONSTANCY OF THE SPECIFIC CHARACTERS AMONG ASTACIDÆ.

The examination of the constancy of the specific characters was a chief point in my labor, especially because Mr. Gerstfeldt, in his excellent monograph concerning the fresh-water Crustacea of Europe, has reduced the number of described species to only two, by proving that the characters relied on in their separation are far from being constant.

The exceedingly rich mass of material before me, thus far unrivalled for such a labor, has permitted a very extensive and careful examination of the constancy of the characters. Otherwise viewed, it could not be denied that this rich material — there being more than a hundred specimens of some species — would rather serve to obstruct the judgment of the worker.

Dr. J. Le Conte, in his careful monograph of the Astaci of Georgia, says: "The shape of the rostrum and of the chelæ and the size of the

areola vertebralis affords the best characteristic marks. I have never known this last character to vary in any degree. In the two others there may occur slight differences of development, not, however, so great as to be of any moment." According to these remarks, Dr. J. Le Conte seems to be convinced that the size of the areola vertebralis is alone constant and always identical, and thus confirms the result of the labor undertaken some years afterward for the European species by Mr. Gerstfeldt. I have to add that Mr. Gerstfeldt does not speak at all of the areola vertebralis, because it is not so well marked in the true Astacus, and that Mr. Gerstfeldt also has proved all the other characters to be variable in some degree. I am obliged to go a little further, and to state that, according to my observations, even thē areola vertebralis varies to a greater or less extent.

Abnormal Gigantic Specimens. — It is very necessary to give up the idea that specific characters should bear a mathematical identity. Crustacea, as is well known, grow continually, and possibly become very old. Therefore we sometimes find of a species, which commonly has certain and smaller dimensions, some old and gigantic individuals, differing in many characters (viz. in sculpture, armature, relative size of parts and members) from the common examples of the same species. As progress is made in the cultivation of the land, and the improvement of the rivers, and especially as the population of the country increases, these giants become more and more rare in the species used as food, as in *A. fluviatilis* of Europe. Perhaps the extraordinary dimensions given by Rafinesque fifty years ago — for *A. limosus* nine inches, for *A. fossor* six inches, while at this time the specimens seen by me are only half as large — are explicable in this way. I remark, however, that the American species are not commonly used as food, except by the French population of the Southern States.

But even aside from these abnormal instances, other younger and older specimens present quite a variable material for comparison and description. If you state, for instance, that the specific characters should be only taken from the full-grown specimens, this statement is not at all decisive, because it is impossible to determine whether a specimen be full grown or not. In Norway it is against the law to sell lobsters not full grown; and the law considers every lobster over eight inches long as full grown, because it is supposed to have spawned three times. But the lobster may become twice that size; it would then differ in sculpture, armature, and the relative size of its members, as mentioned before. The real difference is far greater, as it is reasonable to consider every lobster after its first spawn, although then much smaller, as a full-grown animal.

Although a good and complete description of a species should enable us to determine both the young and the full-grown specimens, still the

careful and right choice of the specific characters seems to depend largely upon the taste of the describer and upon the richness of the materials at his command.

Accidental Variations. — In the first place, all accidental variations are to be excluded. Crustacea are known very easily to reproduce parts damaged or accidentally lost; but these regenerated parts do not often reach the size or form of the old portions. Of course I do not here speak of variations, which are very easy to be recognized, as when one or more limbs are reproduced on one side. But I have seen specimens with the same limbs renewed on both sides, and such specimens, especially if one do not have before him more examples, are sometimes very difficult to recognize, and they often occasion errors (cf. *A. Gambelii*). The most prominent parts of the Crustacea are easily damaged and reproduced, as the claws, the antennæ and their basal lamina, the rostrum, and the caudal lamellæ. But sometimes the more protected parts are found affected in the same manner, as the first pair of abdominal legs, and even the epistoma.

Differences of Age. — The differences of age are of vast importance, and have a great influence on the right understanding of any species. The very young and newly hatched animals are, without doubt, recognizable by anybody. Afterward, as stated, there is more difficulty. The rich materials of the Museum allow the following remarks: —

Though generally the body has a constant form, I agree with Mr. Gerstfeldt, that even here there is no mathematical identity. The oval shape of the body, its greater or less convexity, its compression or depression, the abrupt or gradual curving of its sides, are somewhat variable. These variations, it is true, do not exceed certain limits; but they are here more troublesome, as in the great number of species they seem sufficient to obliterate the specific characters. I say expressly "seem sufficient," as the greatest difficulty consists in expressing these differences clearly and definitely by words, while the worker, who sees the species before him, separates them more easily.

Differences in the Shape of the Head. — A more essential difference in the shape of the head and the great claws is to be found in specimens of different ages. Here these differences are more striking and more troublesome than the relations of the different parts. Their length and breadth, their thickness, compared with that of the body and its limbs, undergo marked fluctuations, and these fluctuations are far from being of the same kind in all the groups of our fresh-water Crustacea. In the several species of the group, of which *Cambarus acutus* is the type, the young animals always have a three-toothed rostrum, though in the older individuals the lateral teeth are often nearly or entirely obliterated. In the group of *Cambarus Bartonii*, on the contrary, the younger animals do not differ in the shape of the rostrum from the older, although

the limbs of the claw-legs are in their proportions sometimes very different in older individuals, the brachium longer even comparatively, the claw longer and thicker, the fingers more curved and furthermore separated from each other at the bases, while other similar differences are to be seen in the antennæ and their appendages, in the shape of the rostrum, and the front margin of the cephalothorax.

Differences in Sculpture. — The differences in the sculpture and armature are naturally much more considerable. The punctation, the granulation, the flat scales, the thorns, the spines, and the teeth, the margins of the thorax and of the great claws, are little or not at all developed in the younger specimens; they are a little more visible in the middle-aged animals; even those that are old and full grown sometimes differ considerably in the degree of development.

Hairyness. — On the contrary, the hairyness of some parts seems a constant character for species, even in the younger animals. But this character is to be found only in few species, and is not generally important.

Older Specimens. — On the whole, it may be said that in the older Astacidæ the form and the sculpture are more strongly exarated; the claw of the first legs is larger and heavier. But, besides the dimorphism of the males described further on, individuals are to be found in a so-called retrograde or arrested development.

Retrograde Development. — Older and larger animals are found, which in the degree of sculpture and armature are considerably behind specimens of similar or even smaller size, and these have apparently stopped at a lower stage of development. Naturally, these individuals are to be found mostly in the group in which the development of the sculpture and of the great claws is greatest, as in the group of *Cambarus acutus*.

Postabdomen. — The form of the postabdomen is constant in the different species; in the females it is usually broader. The external angles of the postabdominal segments are differently shaped, more or less rounded or acuminated. These differences are specific and constant, but usually they are not very remarkable, and they are difficult to describe. The "lamina analis," especially the middle lamina, offers specific characters. Its basal part always has two or three teeth on each side of its front margin. But I must remark, that in shape and size, and even in number, the teeth are often variable. Nevertheless, when rich materials are at hand this character is useful. The form and especially the margin of the apical part of the middle lamina are likewise in some species different, and in some degree constant. I remark, as an example of the difficulty of recognizing occasional accidental variations, that I have seen of *Astacus Gambelii* but two males, one with the apical margin of the middle lamina exactly rounded, the other exactly notched. I consider the latter as perhaps accidentally altered.

Hands. — The hands, or great claws, are, in every description, carefully used as one of the best specific characters. No doubt their form and sculpture are quite different in many species, and offer characters most easy of recognition. Nevertheless, these characters become more and more uncertain as the materials in hand are richer. As I have stated before, the development, the size, and the sculpture of the hands vary considerably between the first and second form males and the females, between the young, middle-aged, full-grown, and gigantic specimens. Even the relative length and breadth differ; the brachium surpasses the eyes or not; the fingers are equal or unequal in length, longer than the rest of the hand or not, straight or curved, denticulated at the margins or not; the carpus has the spines more or less numerous, more or less developed. In the full-grown specimens the hands are surely a constant and good specific character, but even here they vary to a certain degree, and finally it is not at all easy, with scanty materials, to determine with certainty whether a specimen be full grown or not. Therefore I have never given in the different species the exact and detailed measurements of these parts, which are noted by some authors, as I have found these measurements of very little value. The measurements given by me are average measurements, generally of the most full-grown specimens. But I have always been careful to record all the different forms of the hands which I have observed in each species.

The hairyness of the hands, which, like a beard, a brush, or a pencil, is found in some species (*A. Gambelii, C. penicillatus immunis*, etc.), seems constant and a very good specific character; the same is true of the partial hairyness on the first pair of maxillary legs (outside and below, or outside only).

On the basal joint of the fourth and of the fifth pair of legs there occurs a little knob (capitulum), differing in its shape in given species in a constant manner.

Colors. — The colors are apparently of no value. I have not seen living specimens, but Dr. John Le Conte says directly: "All that I have ever seen were much of the same color," and "their color is generally lost with their life, so that it is of little value in the description." All the alcoholic specimens have a similar color, — reddish brown, inclining to a more or less dark olive or dirty yellow. In certain species red spots are occasionally to be found in some species, as noticed in my descriptions. I should remark that the color is apparently altered in alcohol as time advances. The specimens of *C. Bartonii* received within a few weeks are reddish brown, the older ones nearly yellow.

Dr. John Le Conte says expressly that the burrowing species do not differ from those that are aquatic.

THE SEXUAL PECULIARITIES OF THE ASTACIDÆ.

The sexual differences, aside from the genital parts, are often very considerable. In the female the great claw is shorter, smaller, and not so well developed. The sculpture and armature are less, the postabdomen mostly broader, and its legs stronger. Apparently the females have, in many parts, retained the characters of the younger animals. But sometimes there are females with a development not at all inferior, or with one even superior, to that of the males. I am not certain whether, as in the males, any dimorphism is to be found.

Abnormal Females. — It is not impossible in this way to explain, and thus indeed may be explained, many apparent anomalies in females. In these females we find a tendency to a more masculine development, as in the aforesaid males a tendency to a feminine development. Nevertheless, even the rich materials of some species now in my hands are not rich enough to enable me to solve by anatomical examination this interesting question.

The Abdominal Legs of the Males. — The sexual parts of the Astacidæ, especially in the North American *Cambarus*, offer very good and constant specific characters. The abdominal legs of the Astacidæ possess a short, transverse, inwardly situated basal article, and a longer doubled flagellum, consisting of two approximated narrow bands of a more membraneous consistency, flexible, and sprinkled with hairs on the outside. In the males, the first and the second pair are partly transformed. The second pair has the basal half of the inner flagellum corneous and thickened, but the apical half retains the same membraneous shape as the external flagellum and the flagellum of all the following legs. The corneous basal half is dilated at the end and rolled from the inside outward, forming a channel. The first pair of abdominal legs is even more transformed. The articulation between the basal limb and the flagellum is gone, and also the whole external flagellum, as well as the membraneous apical part of the inner flagellum. The remains of the first abdominal leg form a corneous limb, with the apical half dilated and rolled from the outside inward, forming also a channel. This kind of shape is most easily understood in the true *Astacus* from Europe and from California. In the American species of *Cambarus* we find the modifications and different exarations forming, as stated before, very good specific characters. The dilated apical half is so closely rolled together that the channel no longer exists, except very superficially, and the closely rolled part is transformed into two approximate corneous solid cylinders, united above, while below there is an apparent suture, constituting the rest of the channel before described. The tip in each of the two cylinders is not simply truncated, as in the European and Californian *Astacus*, but transformed into more or less corneous

hooks and teeth. We find also in *Cambarus* the tip or the first abdominal legs bifid, and the two branches more or less elongated, equal or not in length and breadth, straight or curved, and very well adapted to form specific characters. Having examined a very great number of specimens, I am able to state that these different forms are very constant in the same species. Naturally here, as elsewhere throughout the group, it is not possible to find an exact mathematical identity, but a constancy within certain limits, and I was able to observe and figure some variations.

The rolled part of the second pair of abdominal legs — I have remarked before that it is rolled in the opposite direction — is apparently analogous to this formation in the first pair, and is formed in the European species exactly in the same manner as in the first abdominal legs. In the *Cambarus* the apical end of the dilated plate is considerably more rolled than the basal end, assuming in this manner a triangular shape. It is interesting to find the same arrangement in the true American *Astacus*.

The Purpose of this Structure. — The purpose of this structure of the first two pairs of abdominal legs is easily explained. The seminal fluid coming out of the basal part of the fifth legs by an open circular aperture, must be conveyed to the sexual aperture of the female, situated farther forward in the inner basal part of the third legs. The first pair of the abdominal legs of the male, being situated closer to the venter, is very well adapted by its channelled shape (represented in the *Cambarus* by the shallow suture) to direct the seminal fluid to the designed part in the female. It is likewise well to notice that the transformed shape of the second abdominal legs gives a considerable help for this purpose in two ways. First, the dilated part, especially in the *Cambarus*, is well adapted to be inserted into the sutured part of the first legs, and mechanically to support the first legs in a horizontal position. The rolled part also serves to complete the channel made by the first legs for the direction of the seminal fluid, and it is well to remark that the inverse manner of rolling, as before stated, serves more completely to prevent any of the ejected seminal fluid from taking a wrong direction. In the Madagascar and most of the Australian Astacidæ these modified abdominal legs, fitted for use in coition, are entirely wanting, and the conveyance of the seminal fluid is perhaps more simple and imperfect.

The Females. — Regularly in the articulated animals, especially in the insects, we find in the genera or families in which the organization of the sexual parts differs specifically in the males, that the females also exhibit differences more or less adapted to the male organs. The striking differences in the male organs of the *Cambari* made the presence of analogous differences in the females probable. But these are not to be found. The female sexual aperture is always

oval, closed by a thick membraneous plate, firmly attached by the outside half, moving and opening inwardly. The oviduct is a simple hole, and, as far as I know, there are no specific differences. In a new gigantic Australian species of *Astacoides*, very near *A. nobilis* Dana the female aperture is more elongated and surrounded by a circular barbe of hairs, apparently designed for the better conveyance of the seminal fluid in a species without first abdominal first legs.

The manner of coition of the Astacidæ has been as yet rarely observed (Cuvier Règne anim., T. IV. p. 89, says: "L'accouplement s'opère ventre contre ventre"); but, on comparing closely the situation of the sexual parts of the male, it is evident that the first abdominal legs partly enter into the oviduct, and certainly no more than with their corneous tips. The length and situation of the parts, and the circumstance that the second pair of legs is apparently firmly fitted in coition to the first legs so as to prevent a farther entrance, seems to prove that perhaps this arrangement only serves to open the membraneous plate of the female parts at the right time. In all the species of *Cambarus* the part of the first abdominal legs of the male, which may and which can only enter into the female aperture, is well marked and separated by a transverse superficial suture.

It is well known that the females of the Astacidæ possess no receptaculum seminis, and so the introduction of the seminal fluid seems without purpose. But as it is stated by Milne-Edwards that he once discovered spermatophores in the female aperture of *Cancinus*, which also has no receptaculum seminis, perhaps the same may occur in the Astacidæ.

Annulus Ventralis.—The female sexual aperture offers no specific characters, but we find some in the ventral, or rather sternal, plates between the last two pairs of thoracic legs, especially between those of the fourth pair. These differences not being very remarkable in the true *Astacus*, although they exist, I never find them mentioned by the authors. But the American *Cambarus* shows well-defined characters, although difficult to describe.

Between the fourth legs we find a broad trapezoidal plate, more or less excavated and elongated in the different species. The posterior end of this plate is ordinarily dilated and on every side angularly protracted. Its surface is smooth or tuberculated. Behind this plate is a supernumerary corneous organ (repeated even between the fifth legs), which gives specific characters. This organ — named annulus in my descriptions — generally forms a short cone, with a transverse oval base and a depressed tip. This cone is divided in the medial line of the body by a denticulated suture, with inflated margins. The tip is often more or less depressed, or even impressed, forming a deep, transverse hole, crossing the denticulated suture. Tab. II. f. 126.

We find inside two approximated, inflated, or vermiform ridges, fol-

lowing exactly the outside suture. The size of this corneous cone, and the shape of the suture and apical hole, differ considerably in the different species, and seem, to some extent, constant in the same species. The structure and shape of this organ seem to be for some sexual purpose. The ridges (in *C. acutus, Clarkii, Bartonii*, etc.) have an inner open entrance on the front margin, and seem opened between the suture outside on the hind margin. In the annulus I found fat and fibrous matter imbedded, and perhaps a glandular mass, which it was not easy to determine in the old alcoholic specimens. Nevertheless, the whole apparatus seems to be fitted for some secretion. Tab. II. f. 127.

The corneous cone in the species of *Cambarus* is well separated from the ventral plate, being only united to it by a membrane, movable in the young and sometimes even in the full-grown individuals. This is a specific character (*C. troglodytes*).

In the true *Astacus* this organ exists; still it is not separated from the ventral plate, except by an external channelled space; it forms a slender transverse ridge, varying in shape in different species, but not so conspicuously, and having no denticulated suture or secretional apparatus.

I have sometimes thought that this apparatus might perhaps serve for gluing the eggs to the abdominal legs; but as this does not exist in the true *Astacus*, it seems improbable. By what is possibly a singular coincidence, I have failed to find, among specimens from more than thirty localities and among several hundred females of all sizes, a single female, in the *Cambari* of the group *C. acutus*, with the eggs attached. Two females have young between the abdominal legs, but no remains of the egg-cases. Do the females of the group of *C. acutus* lay their eggs in a manner different from the other *Cambari?* I presume not.

Eggs: their Attachment and Bursting. — The eggs in the Astacidæ are always attached, as in some insects (in *Chrysopa, Hemerobius, Mantispa*), by a short stem. Before the appearance of the egg the glue is excreted from the female sexual aperture, fixed, and drawn out into a stem; finally the egg is fixed upon it. It is also to be presumed that the Astacidæ fix their eggs in the same manner. I should remark that the stem in the *Astaci* is always much stronger than in the *Cambari*.

It is, perhaps, interesting to notice that the eggs in the true Astacidæ are always burst in the same manner, viz. into two parts perpendicularly, the segments remaining attached to the stem. This condition makes its probable that the *Astacus* embryo has a particular egg-burster similar to that in the insects, although these interesting parts are little observed or known even by entomologists.

Development of the First Pair of Abdominal Legs in the Male. — It is easy to discriminate between the sexes of very young individuals of *Cambarus Clarkii*. This is the case with those only 0.3 inch long, and while they still occupy the postabdomen of the mother. In the females

the sexual aperture is visible at the base of the third set of legs. The first abdominal segment is without any appearance of abdominal legs: in all the other segments the abdominal legs are well developed, their length being nearly two thirds of the breadth of the postabdomen, the basal article being oblong, while the length of the doubled flagellum is a little greater.

In the males the first segment has on each side a little knob, somewhat longer than broad, turning inward. In the interior the developing leg is visible, and its articulation seems marked. This oval knob, with rounded tip, is the beginning of the first pair of abdominal legs. I have seen the same form of the first abdominal legs in the young of *C. Bartonii*, even 0.55 inches long. Tab. II. Figs. 133, 134.

Second Form of the Males. — I have examined the further development in *Cambarus acutus*. In the younger specimens, 1.7 inch long, the legs are more developed, the basal third articulated. The shape of the legs is nearly the same as in the full-grown animal, but narrower, more curved, the tip a little broader, the teeth more obtuse. In the older specimens, 2.7 inches long, the legs are the same as in the full-grown animal, which is over four inches long. Occasionally, both in younger and in full-grown specimens, the articulation is partly gone, but its remains are still visible on the upper margin; in some cases the articulation has entirely disappeared.

This form, which is always visible in the very young and in middle-aged specimens, ordinarily with an articulation, I have described as the second form of the male.

First Form of the Males. — In all species seen and examined by me, many old, full-grown males have the first pair of legs of a particular shape, analogous in a certain view to the form before described, and always found in the young animals, but differing in the following particulars.

The articulation is entirely gone; the tip of the leg is more distinctly finished and not so membraneous; the hooks are horny; the teeth or bifid ends longer and more separated; the hairyness, if any exists, more profuse. I have figured these parts in nearly all the species, and described them as the first form of the male. I think it is well to observe that, in the second form of the males, they are always developed in a manner visibly less complete than in the first form.

The males of the second form differ also in another way from those of the first form. The hooks on the third article of the third, or in some groups of the third and of the fourth, pair of legs are smaller and less developed. The whole body has less size and width, the sculpture is not so well finished, while the claws are shorter, narrower, and more like those of the female.

A closer examination of the rich materials at the Museum shows that

all the young male specimens of *Cambarus*, without exception, pertain to the second form. But there are also not a few large males belonging to the second form, which have retained the articulation and the shape of the tip of the first abdominal legs proper to the young specimens. The articulation is sometimes entirely or partially gone. Among nearly fifty full-grown males of *Cambarus acutus*, about twenty-five belong to the second form; while among fifty young males, nearly a dozen have, for the most part or entirely, lost the articulation. Tab. II. Figs. 112, 113.

The discovery that every species of *Cambarus* possesses two different forms of males was made by Professor L. Agassiz.* and kindly communicated to me.

Dimorphorism, or perhaps a Sterile Form. — The existence of a second form of the male, if it were no more than a passage or metamorphotic form, would not be extraordinary. But the great number of full-grown second-form specimens in every species, which are often even larger than the first-form males, seems to prove that they are individuals which have remained in a sexual stage that does not agree with their corporal development, — in short, that they are perhaps sterile.

The objection that these second-form males may be individuals shortly before or shortly after the casting of the skin I can surely refute, as I have seen many specimens at this stage of growth; the Museum collections exhibiting the animal in all the different phases of its existence.

Another objection, that the males of the second form, or perhaps those of the first form, are abnormally developed individuals, is refuted by the great number of the two forms existing and living together.

The conjecture, on the other hand, that the second-form males may be sterile, is really supported by the anatomical examination of the two forms in the principal groups of *Cambarus*.

Internal Sexual Parts of Cambarus Male. Of C. acutus. Tab. II. Figs. 120 – 123. — In two full-grown males of *Cambarus acutus*, first and second form, both four inches long, the testicles are trilolate, as in *Astacus fluviatilis*, but much smaller, the vasa deferentia shorter. In the first-form males the two superior lobes are pyriform, truncated above, united below in a membraneous hole a little shorter than the testicles, and connected with the third inferior lobe. Where the two superior are united, the vas deferens begins on each side, being vermiform and shorter than the body. The testicles in a *Cambarus acutus*, four inches in length, are but 0.3 inch long; while in an *Astacus fluviatilis*, two inches in length, they are 0.6 inch long, thus much larger,

* Intending many years ago to describe the North American Astacidæ, he made a close inspection of the material he had collected for that purpose. Observing the different shape and organization of the first pair of abdominal legs, he was led to this important discovery.

and there is no membraneous hole, as the three lobes are closely approximated: the vasa deferentia are also stronger, more curved, and have greater length than the body. Their end is visibly more dilated than in *Cambarus acutus*.

In the second-form male of *Cambarus acutus* the testicles are similar but smaller, the superior lobes narrower, oval; the inferior lobe is acuminated, narrower, and not bigger than the connecting hole of the superior lobes. The vasa deferentia are shorter. The microscopic examination of the contents of the testicles offers no further argument, as the specimens have remained too long in alcohol.

Of C. virilis. Tab. II. Figs. 128–132. — In the first-form male of *Cambarus virilis*, 3.2 inch long, the testicles are somewhat similar, but longer, being in length 0.7 inch. The superior lobes have a prismatic form, with diverging acuminated ends. The prismatic part is excavated above, and much separated from the smaller and compressed hole. The inferior lobe is long and compressed, seen sidewise, oval, and truncated behind. The vasa deferentia are longer than in *Cambarus acutus*, while their ends are not visibly dilated.

In the second form of *Cambarus virilis*, 2 inches long, the testicles are shorter, the superior lobes prismatic, but the superior part is not much separated: the inferior lobe is shorter, beginning with a narrow hole, laterally more compressed: the vasa deferentia are shorter and narrower.

Of C. Bartonii. Tab. II. Figs. 135–138. — In the first form of the third principal group in *Cambarus Bartonii*, 2 inches long, the sexual parts are more similar to those of *Astacus fluviatilis*. They are 3.5 inches long, the superior lobes oval and large, while their superior tip is a little contracted. Connected by an inferior, well-separated, smaller membraneous hole with the equally long hole of the inferior lobe, there is to be found behind the connecting joint an inflated tubercle, while lower down there is another which is similar but smaller. The inferior lobe is pyriform, inflated behind, somewhat compressed laterally. The vasa deferentia are stronger and longer, the ends being visibly dilated.

In the second-form male of *Cambarus Bartonii*, 2 inches long, the testicles are shorter, the superior lobes more trigonal, the inferior narrower, elongated, much more compressed, acuminated behind, the connecting holes not so well separated and finished, without tubercles behind, while the vasa deferentia are narrower and shorter, the ends not being visibly dilated.

I may remark, that in the first-form males of *Cambarus acutus* and *Bartonii* the three lobes of the testicles exhibit the same granulated contents as in *Astacus fluviatilis*. But in *Cambarus virilis* they are white and have a fatty appearance, similar to those always found in the second-form males.

The sexual parts of the second-form males are so much less developed that it would be allowable to consider them as sterile. An anatomical examination of the second-form males without articulation in the first abdominal legs was not possible, as the materials were not sufficiently abundant.

As before stated, I surmise the presence of similar sterile females; which as viragoes show more of a male type.

An anatomical examination of the females of *Cambarus acutus* and *Bartoni* reveals some difference in the shape of the ovarium.

Internal Sexual Parts of the Cambarus Female. Of C. acutus. Table II. Fig. 123.— In *Cambarus acutus* the ovarium is nearly an inch in length, elongated, narrow. The two superior lobes are shorter, cylindrical, a little inflated at the base; the inferior lobe is elongated, conical. The connecting part is more enlarged, and gives on each side a large oviduct. Above this part is situated a strong membrane, which passes with an acuminated tip between the superior lobes; it is provided laterally with some bands of "musculi alati," while the fibres are strongly striated transversely. This membrane also shows several nerves, apparently belonging to the nervus sympathicus.

Of C. Bartoni. Table II. Fig. 129.— In *Cambarus Bartoni*, 2 inches in length, the ovarium is 0.65 inch long, and larger. The superior lobes are shorter and oval; the inferior a large cone. The oviduct is even broader. The membrane is similar to that in *Cambarus acutus*. In both species examined, the ovarium was filled with eggs of different sizes and degrees of development.

No Dimorphism in the true Astaci.— The existence of two forms of males in the *Cambarus* of North America has been proved by me in all species in which I was able to examine a large number of specimens. In five species, represented only by single specimens of first-form males or females, I have not seen the second form. But the existence of this second form will be by far the more interesting, since it seems that in the *Astacidæ* only the *Cambarus* possesses two forms of the male. I have examined nearly two hundred specimens of *Astacus fluviatilis* from different European localities (Germany, Switzerland, France, Scotland), without finding a difference in the males. I must add that I have not seen very young specimens, and do not know at all whether the young have the first pair of abdominal legs articulated as in the *Cambarus*. The smallest specimen seen by me is 1.5 inch long. Of the Californian *Astaci* I have not seen more than a dozen males. All these were quite full grown, and without any differences answering to the second form of *Cambarus*. Of the Amur species I have seen but one female.

Dimorphism in other Crustacea.— Perhaps this fact of the existence in the crustacea of two forms, one always sterile, is not unique. In the

genera Lupa and Callinectes there are not rarely females with a very narrow and acute postabdomen. These it is very easy to separate from the ordinary females, with large and circular postabdomen. Professor L. Agassiz informs me that he has satisfied himself, by an anatomical examination of living specimens, that these females are sterile. I have found similar females with a narrower triangular abdomen in some other genera of *Brachyura*.

I am indebted to Mr. Alexander Agassiz for the information that F. Müller, Fuer Darwin, 1864, has described two forms of the male in *Orchestia Darwinii* and in *Tanais dubius*. He remarks that when found upon the shore the form of the second pair of gnathopoda varies from that of specimens found at a distance inland, where it lives under mouldy leaves in loose earth. In *O. Darwinii*, intermediate forms between the males with large and those with small hands are not to be detected, but in two other species, *O. tucurauna* and *O. tucuratinga*, the shape of the antennæ and of the hands changes even in the full-grown males.

The supposition that the first-form males only in *Cambarus* possess large hands for burrowing purposes is to be rejected, as the females also have the same burrowing habits.

The existence of two different forms of males in *Cambarus* is very important in the description of the species, and the fact that these forms are not recognized by all preceding authors may explain some erroneous determinations in their works.

Dimorphism in Insects.— The discovery of a dimorphism in the crustacea is all the more interesting, since as yet in the whole animal kingdom dimorphism was known only in the insects. There are many facts and communications scattered through entomological literature, of which a general review is very desirable. An anatomical examination of these dimorphic forms is still wanting, only the external differences having been thus far marked.

The dimorphism seems to be represented in two different ways; a difference only in the colors (dichroic forms of Brauer), or a difference in size and shape, and mostly in the female. I should remark that dimorphism, as observed in insects, occurs only in one sex of the same species, and mostly in the female. Perhaps in the ants and in the white ants — it seems more natural to range all the socially living insects, viz. the ants bees, wasps, and white ants under the same law — a dimorphism is to be found in both sexes.

Dimorphism consisting in different colors was long since observed, especially in Lepidoptera, in the hind wings of many Orthoptera, and in the females of Agrion. In the latter genus the well-known orange-colored females are probably sterile.

Dimorphism with difference in shape and size is also often observed. A very common case is the difference in the development of the wings.

The wings are either long and well developed, or short, or entirely wanting. The short-winged Orthoptera (Gryllus, Locusta, Blatta, Perla, Termes, Psocus) have been carefully described by Messrs. Fischer, Von Siebold, Lucas, Brauer, and myself; the short-winged or apterous Hemiptera, by Westwood and Uhler (Amphibiocorisiæ, Gerridæ, etc.); the short-winged Diptera by Schaum (*Ornithobia* and *Lipoptera*). Mr. Brauer has recently given an interesting paper upon dimorphism in the genus Neurothemis, which belongs to the Odonata. The dimorphic females have wings with a less complicated neuration and different colors. There is even a case of trimorphism in some butterflies, according to the observations of Mr. Wallace. *Papilio Ormenus*, from Celebes, has three distinct forms of females, and in some cases the number of female forms appears to be four. Dimorphism consisting in different shape and size is observed in the Lepidoptera (Equites, etc.), in the Coleoptera, in the Lamellicornia, and in the Longicornia, and perhaps in the Lymexylon and Hylecœtus; in the Hymenoptera (Cynips); in the Diptera (Phasia). The dimorphism in the Dipterous genus Phasia, discovered by Loew, is very remarkable. Having seen his specimens, I may be permitted to add here a written communication by Mr. Loew, sent to me some years ago and still unpublished: "In the genus Phasia every species has two male forms; one similar to the female, and another much larger, with the wings broader and more colored, and usually the body more colored. The two forms fly at the same time and unite with the same form of females. The genital parts of the larger males are in shape and size identical with those of the smaller males. There exist some intermediate forms of males, and it is sometimes, in certain species, possible to form a complete series, which seems to unite the two different forms. I say seems, because I have never seen a male which I hesitated to place in one of the two forms."

I have noticed here the occurrence of dimorphism in the insects to show how variable in the different families and genera is the mode of dimorphism, even from that observed in the *Astacidæ*. Perhaps a closer examination will disclose even some difference in the sexual parts in certain dimorphic insects, and it now seems probable that some forms, heretofore described as distinct species, will be hereafter recognized as only dimorphic variations. Still, it is possible that very different facts are to-day united under the same name of dimorphism.

Certainly the discovery of a dimorphism in another part of the Articulata, viz. in the Crustacea, leads us to suppose that it will be found also among the worms.

The Rarity of Varieties is an Important Character for Cambarus. — The rarity of varieties in the genus *Cambarus* is worthy of remark, and may be considered as an important character of this genus. In the true *Astacus*, the two species living in Europe vary so much that even by

eminent naturalists these varieties have been taken for nine different species. In the genus *Cambarus*, the thirty-two known species show comparatively very few varieties. But of three of these, viz. *C. acutus*, *C. virilis*, and *C. Bartoni*, the described varieties differ in a more considerable manner; while perhaps some of them, especially of *C. Bartoni*, will be hereafter recognized as different species. Indeed, the fact is too striking to be overlooked; here there are few species and many varieties, there many species and few varieties.

CAMBARUS Erich.

The question, Is *Cambarus* a peculiar genus different from *Astacus* or not, is one of great importance to me as monographer. The historical statements already quoted are all that have been made, so far as I know, upon the subject. It would no doubt have been more easy for me to judge of the importance of the generic characters if I had been able to study in the same manner all the species of the old genus *Astacus*. But the materials before me, except for North America, are not sufficient; some genera are entirely unrepresented, of others only a few specimens are at my disposal. I therefore confess that my judgment upon a division of the old genus *Astacus* into more genera is not completed; still, after a rather close examination, I am convinced that *Cambarus* forms a very good and natural genus, and that, if it be not accepted, a very great part of the actually adopted genera must be equally rejected.

The differences between *Astacus* and *Cambarus* are as follow:—

1. The general form of *Astaci* is clumsier, coarser, and more oval. The *Cambari* are more elongated and more cylindrical.

2. The absence of the gill on the fifth pair of legs in *Cambarus* is first quoted by De Haan. *Cambarus* has seventeen, *Astacus* eighteen gills. But there is also another difference, not before noticed. In *Astacus* each pair of gills, except the single one on the fifth set of legs, has a broad, deeply folded membrane, closely fixed behind the most external gill lobe. In *Cambarus* this membrane is always wanting in the gills on the fourth pair of legs, but exists, as in *Astacus*, in all the others.

In the true *Astacus* all the gills with a folded membrane behind have a basal external bundle of shorter but broader and irregularly placed gill tubes; these are never to be found in *Cambarus*. The superior external plate of the fifth pair of legs in *Cambarus* is surrounded by longer featherlike hairs; in *Astacus* we find but few on the posterior border; *C. pellucidus* is similarly organized to the true *Astacus*.

I may remark that the breadth of the areola or the medial postdorsal region (Dana) seems not to depend, as it would be easy to suppose, upon the presence or absence of the gills on the fifth pair of legs. We

find in some *Cambari* (*C. spiculifer*, *versutus*) this areola even as broad as in many true *Astaci* with gills (*A. Klamathensis*, *Gambeli*), but in general the areola is never so well marked in *Astacus* as in *Cambarus*.

3. The inner antennæ in *Astacus* have a peculiar structure and shape. They are always very short and more conical (the basis thicker); the inner flagellum is considerably more slender and shorter, while the joints of the flagellum are more spherical, calcareous, and more fragile. Of course the inner antennæ are easily broken in the preserved specimens. In *Cambarus* the inner antennæ are visibly longer, the flagellum is equally long, and of the same structure as the outer antennæ.

The lamina of the outer antennæ has a prismatic shape in *Astacus*, the external border is much thickened. In *Cambarus* the lamina is visibly more membranous.

The basal article of the inner antennæ has an anteapical spine beneath in *Astacus*; in *Cambarus* this spine is always situated in the middle of the article, or more basally.

4. The epistoma in the true *Astacus* is more solid, conical, a little contracted before the tip. It is in *Cambarus* more flattened, often excavated beneath, always larger, and never contracted before the tip.

5. The ear, or what is considered the auditory organ, forms in *Cambarus* (as in *Astacoides*, *Homarus*, and perhaps in *Cherax*) a very short cone or a slightly elevated ring, closed above by a membrane, considered as the tympanum. The true *Astaci* are an exception, and have this organ differently shaped, with a more elevated cone, rounded on the top, and a narrower tympanum behind.

6. The parts which serve for sexual purposes in *Cambarus* differ essentially from those in *Astacus*. In *Cambarus* these parts are organized in a particular manner, and differently in every species. This is very important, as it is well known that in the Articulata very nearly allied genera often differ constantly in such a manner. This difference seems a criterion for separating two genera in forms otherwise nearly related.

These differences are as follow: Dimorphism is to be found in the males. The first pair of abdominal legs is differently formed: the apical half is not simply rolled as in *Astacus*, but transformed into two solid approximated parts, with the tips more or less protracted and differently finished.

In the females is to be found behind the sternum, between the fourth (and fifth) pair of legs, a particular separated part, — annulus, — differently shaped in the different species. In *Astacus* this part exists indeed, but it is never separated from the sternum, and is represented by a ridge, either straight and transverse or curved and broken behind. The particular shape of the annulus in *Cambarus*, with its denticulated median suture and its transverse hollow impression, is evidently anal-

ogous to the form in *Astacus*, but produced in a different and exaggerated manner. The hinder part of the sternum is separated and curved, not backward, as in *Astacus*, but forward and entirely rolled.

I may remark that, according to my anatomical investigations into some species, the internal sexual parts in males and females of *Cambarus* differ from those in *Astacus*. The three lobes of the testicles and the ovarium are larger, rounded, and closely approximated in *Astacus*, the vasa deferentia longer than the body. In *Cambarus* the three lobes are small, elongated, and separated; the vasa deferentia shorter than the body.

It would be very interesting to prove that the young of the genus *Cambarus* are hatched from the eggs in a similar but more advanced stage of development than the young of the genus *Astacus*, described by Professor Rathke. But the materials in my hands are not sufficient for this purpose, the smallest seen by me being 0.3 inches long, and belonging to *C. Clarkii*. The rostrum is incurved, but always tridentate; the interior antennæ have the flagellum short, and the exterior branch visibly thicker than the interior. The three anterior pairs of legs have nearly the same shape, the first pair is a little longer. The appendage to the legs of the young lobster, described by Thompson, Rathke, and others, does not exist at all. The abdominal legs do exist. The hooks on the third and the fourth pair of legs of the males are not developed. It is easy, as I have before intimated, to discriminate between the two sexes. The eyes are visibly more developed than in the more advanced animals.

With reference to the further division of the genus *Cambarus*, it was especially important to decide whether all North American *Cambari* belonged to the same genus or to different genera. I am now convinced that all the species I have seen form only one genus, containing several more or less well-defined groups. In this manner the genera *Cambarus* and *Astacus* seem very natural and of equal value. But I have no doubt that some time the genus *Astacus* will be divided into three genera (for the European, North American, and Asiatic species), and *Cambarus* into three or it may be into six genera as Prof. Agassiz thinks.

The division of *Cambarus* into groups is not difficult, except in a certain view: first, as the most striking characters are to be found only in one sex, in the males; and secondly, as some species seem to form a sort of medium uniting the different groups. The first objection is only of value to the naturalist who works with few materials, perhaps mostly females, and is therefore not able to determine the groups to which his specimens belong. But here the fault lies only in the scantiness of his materials, and not in the principle of classification. The second objection would be more important if it were quite certain that there are intermediate species. Perhaps these species only seem to be inter-

mediate, and if not, finally, Nature never agrees with the strict principles of a particular scheme, so that apparently capricious aberrations are to be found everywhere the stumbling-blocks of the naturalist who wishes to arrange everything in a regular series.

A principal character suggesting the division of *Cambarus* into groups is to be found in the hooked legs of the males. This character divides all the species into two great groups, one with hooks on the third and the fourth pair of legs, the other with hooks only on the third pair of legs. This characteristic seems preferable to the later mentioned one, because it unites forms which are related in all other respects, while the groups divided according to the form of the rostrum unite species which are otherwise quite unlike.

In number and situation the hooks are always identical and very sure. Among nearly a thousand males I have found only one abnormal male with no hooks at all. I have never observed any aberration in the group with hooks on the third and on the fourth pair of legs, except a few second-form males of *C. pellucidus*, with the hooks on the fourth legs very small, even in one case not at all developed. In the other group, with hooks on the third set of legs, sometimes, but very rarely, males are to be found with hooks more or less developed on the second pair of legs, but never on the fourth pair. I may add, that the second-form males always have less developed hooks, and that all show the hooks except the very young and newly hatched males.

It is worthy of remark, and seems to prove the importance of this character, that the hooks are situated on the same joint and at the same place as the embryonal appendages of the legs in the young lobsters (*Homarus*), described by Professor Rathke and others. These afterward disappear, and are not to be found at all in the young of *Astacus fluviatilis*. Indeed, these hooks do not exist in the young *Cambari;* their development is later; but the analogy is too striking to be overlooked, and suggests the great desirableness of an accurate acquaintance with the embryological development of *Cambarus*.

According to the number of hooked legs, *Cambarus* is also divided into two groups: —

I. Third and fourth legs hooked, — group of *C. acutus*.

II. Third legs hooked, — all the rest.

The second important character for the division of *Cambarus* into groups is the shape of the rostrum. Mr. Girard has employed this character as a principal one, and forms three groups, with the following characters: —

Rostrum subquadrangularly elongated, tridentated at the tip, — *C. affinis* and allied species.

Rostrum short, broad, conical, toothless, — *C. Bartoni* and allied species.

Rostrum very much elongated, conical, with a small and acute spine

near the extremity, sometimes, however, but very slightly developed. — *C. acutus* and allied species.

This character is indeed good, but sometimes not so striking as to prevent a mistake, which even Mr. Girard himself made, in placing *C. pellucidus* in his first group. There are some species in every group, the exact place of which is uncertain. At first sight the *C. spiculifer* and *C. versutus* would be placed in the first group, and not in the third; *C. penicillatus* and *C. Wiegmanni* near *C. Bartoni* in the second group, and not in the third; *C. immunis* in the second, and not in the first; *C. advena* and *C. Carolinus* in the third, and not in the second, — to which in reality they respectively belong. But generally, I repeat, this character is good, if not *prima vista*, at least in connection with the other characters.

Nevertheless, in the rostrum is to be found another important charter. In one group the rostrum never has lateral teeth at the tip, in all others these lateral teeth are to be found, if not in the full-grown specimens, yet always in the young. But the latter fact renders this mark evidently less useful than the character taken from the hooked legs. In the last case only the newly hatched specimens have no hooks and are doubtful; but in the other instance only the newly hatched specimens always have teeth, while the full grown are sometimes toothless. *C. acutus* and the allied species always have in the young specimens well-developed teeth, and the form of the rostrum is therefore altered in such a manner as to place them *prima vista* in Mr. Girard's first group, near *C. affinis*. *C. penicillatus*, though toothless when full grown, has well-developed teeth when young. *C. immunis*, and in some degree *C. virilis*, *C. propinquus*, and others, are in the same condition.

According to the absence or presence of the lateral apical teeth of the rostrum, *Cambarus* is divided into two other groups, not coinciding with those already mentioned: —

I. Always toothless, — *C. Bartoni* and allied species.

II. With teeth, at least in the young, — all the rest.

Combining the two principal characters mentioned, — the number of the hooked legs and the toothless or toothed rostrum, — we find three well-defined groups: —

I. Third and fourth legs hooked, rostrum toothed, — *C. acutus* and allied species.

II. Third legs hooked, rostrum toothed, — *C. affinis* and allied species.

III. Third legs hooked, rostrum toothless, — *C. Bartoni* and allied species.

These groups coincide with those established by Mr. Girard, after removing his erroneously placed species, viz. *C. pellucidus*, *C. Oregonus*, *C. Gambeli*.

Some other characters serve to evince more or less clearly the naturalness of these groups.

The first abdominal legs of the males show three different forms: —

I. The exterior part is nearly truncated at the tip, with three little partly dilated corneous incurved teeth; the interior part has a short acute tip, for the most part outwardly directed, — *C. acutus* and allied species.

II. The two parts have elongated, straight, acute tips. — *C. affinis* and allied species.

III. The tips of the exterior part forms a larger tooth, which is strongly recurved; the tip of the interior part is broken, short, and conical, — *C. Bartoni* and allied species.

I may remark that there are three exceptions to this character: *C. extraneus*, belonging to the group of *C. affinis*, has the abdominal legs formed as in the group of *C. Bartoni*; *C. advena* and *C. Carolinus*, belonging to the group of *C. Bartoni*, have the abdominal legs similar to the group of *C. acutus*.

The other characters examined by me are not so striking. The antennæ are more slender, as long as, or longer than, the body in the group of *C. acutus*; they are thicker and mostly shorter in the others. In *C. acutus* and the allied species the flagellum of the inner antennæ is longer, while its branches are equally long. In all the other species the flagellum is shorter, and the external branch somewhat longer, than the inner. The antennal lamina is more elongated and enlarged before the middle in the group of *C. acutus*; shorter and enlarged near to the tip in the group of *C. Bartoni*; longer and enlarged in the middle in the group of *C. affinis*. But here are to be found more numerous exceptions, — *C. pellucidus*, *C. Wiegmanni*, *C. Carolinus*, *C. lancifer*, etc., lack the form characteristic of their group.

Cambarus. — *Corpore elongato; pedibus quintis branchiis nullis; antennis internis flagello longiori; auro annulari, apice aperto; pedibus maris tertiis, vel tertiis et quartis articulo tertio unguiculatis; pedibus abdominalibus maris bifidis; femina annulo ventrali conico, perforato, separato.*

I. GROUP. (Type, C. acutus.)

The third and the fourth pair of legs of the males hooked; rostrum triangular, elongated, with an antesapical tooth each side, at least in the young; first pair of abdominal legs with the exterior part truncated at the tip with several somewhat dilated incurved corneous teeth, occasionally covered with a pencil of hairs; the interior part terminated in a short, acute, and for the most part outwardly directed spine.

This group seems very natural, if we except some abnormal species, viz. *C. penicillatus*, *C. Wiegmanni*, and especially *C. pellucidus*.

The body and the hands are more slender and elongated. The flagellum of the inner antennæ has the branches of equal length. The

length of the antennæ equals that of the body, or exceeds it; their lamina is elongated, and dilated near the base; the basal joint of the inner antennæ has an inferior spine before the middle. The foreborder of the cephalothorax is angulated behind the antennæ.

In *C. troglodytus* burrowing habits are observed.

It is worthy of remark that in the considerable number of females seen by me, eggs are in no instance attached to the abdomen. Perhaps the females live more retired now than formerly, and are not easily secured. I have seen many females of various species of the other groups with eggs attached to the abdomen.

The species contained in this group are divided into four natural sections, having the following characters: —

1. The rostrum is broad, very long, triangular, with a small spine near the extremity, somewhat, but very slightly, developed (always strongly developed in the young); the postabdomen is as long as the thorax; the hands are elongated; the antennal lamina is long, and enlarged near the base, — *C. acutus* and allied species.

2. The rostrum is broad, very long, triangular, with a strong and acute apical tooth on each side; the postabdomen is longer than the thorax; the hands are elongated; the antennal lamina is long, and enlarged near the base, — *C. spiculifer* and allied species.

3. The rostrum is broad, triangular, not so much elongated, without ante-apical teeth (always developed in the young); the postabdomen as long as the body; the hands are shorter, broader; the antennal lamina is shorter, and enlarged near the tip. — *C. penicillatus* and allied species.

4. The rostrum is broad at the base, very long, with a strong and acute tooth each side; the postabdomen is longer than the thorax; the hands are elongated; the antennal lamina is long, and much enlarged near the tip, — *C. pellucidus*.

The most aberrant species is *C. pellucidus*. Like the other animals living in caves, it is blind. The eyes are atrophied, smaller at the base, conical, instead of cylindrical and elongated, as in the other species. The cornea exists, but is small, circular, and not faceted; the optic fibres and the dark-colored pigments surrounding them in all other species are not developed. The shape of the rostrum is somewhat analogous to that of *C. affinis*, the margins are more parallel at the base. The lamina of the antennæ is long, but strongly dilated nearer to the tip; the epistoma is shorter and broader than in the other species; the basal joint of the inner antennæ has a spine at the tip, which in the other species is always nearer to the base; the foreborder of the cephalothorax is not angulated behind the antennæ as in all other species.

Nevertheless, the number of the hooked legs, the form of the abdominal legs, and the elongated body and hands, exclude *C. pellucidus* from

the other groups. Some, no doubt, will prefer to regard *C. pellucidus* as a distinct group or genus, still, as I am convinced, without foundation. The most striking differences consist in the aberrations in the shape of the fore parts and of the limbs of the head. But it seems to be a somewhat well-recognized law in nature (Rathke, Metamorph. Retrograd., p. 125) that if any part is atrophied, or stopped in development, the nearest parts show an abnormal increase of development. This is apparently the case in *C. pellucidus;* the eyes are atrophied, and the rostrum, the fore border of the cephalothorax, the antennal lamina, the basal joint of the inner antennæ, and the epistoma are altered or largely developed.

Similar alterations are not rarely noticed in the insects. The blind soldiers of Termes have the head and the mandibles more developed, the maxillæ and the labium atrophied. Analogous facts are observed in the ants and in the two very nearly related Coleopterous species, *Hylecœtus dermestoides* and *flabellicornis*. In *H. dermestoides* the antennæ are simple, the maxillary palpi extraordinarily developed; in *H. flabellicornis* the antennæ are much developed and the maxillary palpi simple. It would not be difficult to give a greater number of similar examples.

The two species of the third section are not as abnormal as *C. pellucidus*, and they differ only in the two characters before mentioned.

Synopsis of the Species.

1st Section. (See p. 33.)

a. Epistoma rounded in front: *C. acutus, C. Blandingii.*
b. Epistoma truncated in front: *C. Clarkii, C. troglodytes.*

2d Section. (See p. 33.)

a. Areola narrow: *C. fallax, C. LeConteï.*
b. Areola broad: *C. spiculifer, C. angustatus, C. versutus.*
(*Incertæ sedis.*): *C. maniculatus.*

3d Section. (See p. 33.)

C. penicillatus: C. Wiegmanni.

4th Section. (See p. 33.)

C. pellucidus.

1. Cambarus acutus *Girard.*

Cambarus acutus Girard, Proc. Acad. Philad., T. 6, p. 91.

Figures on Pl. I., II., and III.
First abdominal legs of the male:
first form, fig. 1 in front; fig. 2 outside; fig. 108 outside viewed more laterally; fig. 106 inside.
second form, fig. 4 in front; fig. 3 tip augmented; fig. 5 outside.
fig. 110 outside, young, 1.7 inch long; fig. 111 outside, 2.7 inches long.
fig. 112 outside, 2.7 inches long, not articulated; fig. 113 outside, 1.4 inch long, not articulated.
var. A, first form, fig. 107 inside; fig. 109 outside.
Venter between the fourth pair of legs of the female, fig. 114, *C. acutus;* fig. 115, var. A.
Rostrum, fig. 116, *C. acutus;* fig. 117, var. A.
Epistoma, fig. 118, *C. acutus;* fig. 119, var. A.
Thoracic line, fig. 124, *C. acutus;* fig. 125, var. A.
Inner sexual parts of the male:
first form, fig. 120; testicles viewed from above, fig. 121.
second form, fig. 122.
Inner sexual parts of the female, fig. 123.
Annulus ventralis of the female, fig. 126 outside; fig. 127 inside.
Antennal lamina, fig. 143, *a*; epistoma, *b*; spine of the second joint of the exterior antennæ, *c*; fig. 144, the same parts for var. B, from New Jersey.

Mas. Rostro triangulari, lato, dimidio longiori, subdeflexo, ante apicem brevem acutum utrinque subsinuato, margine punctato-lineato; supra lævi, subexcavato, basi late foveolato; cretis basalibus extus sulcatis, apice subacutis, fere parallelis, postice callosis convergentibus. Antennis externis corpore æqualibus vel longioribus, articulis duobus basalibus dente externo brevi, subacuto; antennis internis articulo basali ante medium dente infero, acuto; lamina externa rostro longiori, antennarum pedunculo æquali, lata, apice rotundata; margine externo inflato, apice brevi-spinoso. Epistomate brevi lato, excavato, antice rotundato. Pedibus maxillaribus externis intus et subtus barbatis. Thorace postice latiori, densius tuberculato; cephalothorace supra fere lævi, parce-punctato, postice obsolete bicalloso; linea profunda, sinuata, lateribus divisa, spina infera ad antennarum basin apicali, modica; areola angusta, carinata, postice latiori, plana, interdum transverso-impressa; margine postico subexciso. Postabdomine lato, apicem versus subangustiori, lævi, parce-punctato, segmentis utrinque macula obsoleta rubra; segmentis penultimis angulo externo postico recto; lamina media parte apicali breviori, apice rotundata, margine medio exciso; parte basali apice utrinque bispina. Pedibus anticis valde elongatis, corpore interdum longioribus; chela longa, angusta, modice tumida, squamoso-tuberculata; margine interno longo, subrecto, fortiter dentato; digitis longioribus, interno sublongiori, supra planis, subtus medio elevatis; externo recto, interno sinuato; digitis basi tuberculatis, externo tuberculo medio et basali interno; interno basi intus exciso, margine externo basi tuberculato. Carpo longo, latere interno

tuberculato, margine interno spinis duabus, antica majori; subtus spinis majoribus duabus anticis, aliisque minoribus internis. Brachio elongato, rostro longiori, extus lævi, intus ante apicem et margine supero tuberculato, spinis duabus anteapicalibus obliquè positis; subtus biseriatim spinoso. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis et quintis capitulo basali, quartis elongato-ovali, quintis compresso, laminato. Pedibus abdominalibus brevibus, rectis, validis, apice vix-bifidis; parte externa majori, apice barbata, dentibus tribus fusco-corneis, subincurvis; parte interna dente apicali acuto, obliquo, partem externam fere superanti.

Forma II. differt unguiculis pedum minoribus; pedibus abdominalibus basi articulatis, parte externa fere obtusa, dentibus obsoletis; parte interna dente apicali crassiori, conico.

Mares formæ secundæ variant sæpe brachio rostro breviori, interdum chelis brevibus, valde angustis, digitis rectis, lævibus; rostro forma variabili, latiori, marginibus rectis vel subincurvis, acumine angustiori, utrinque magis sinuato.

Femina differt pedibus anticis chelisque brevioribus, extus lævioribus; ventre inter pedes quartos antice tuberculo majori, postice bi-vel bisbituberculato; annulo ovato, fissura longitudinali, labiis alternato-inflatis. Chela interdum basi rubro-maculata.

Variet. A.

A great number of specimens from Illinois (Lawn Ridge, Basson Ridge, Evanston, Athens, and Peoria) and from Indiana (Mus. Salem), comprising both forms of the male and the female, which differ as follows: The rostrum has the margins not so arcuated at the base, the margins are more straight; the epistoma is often more pointed; the transverse line of the thorax is less sinuated, but usually with a lateral spine. The shape of the first pair of abdominal legs is different; seen sidewise the apex more dilated, not hooked behind, the apical teeth are a little larger, and pointed. The female has the ventral segment between the fourth pair of legs not bituberculated, but with a slightly elevated carina; the ventral segment between the fifth pair of legs is more sharply pointed, its articulation-membrane reaching farther to the tip of the base of the abdominal legs. The hands often have large red basal spots.

I have seen very full-grown females, the males not so full grown as those from New Orleans.

Varietas ? B.

I have seen six adult females from Essex, New Jersey; New York; and Beaufort, North Carolina. At first they seem to belong to another species. The lamina of the antennæ is much smaller at the tip; all have a lateral thoracic spine; the rostrum appears narrower in front

of the tip; the tip is more sinuated, with sharper lateral teeth; the hands are smaller and smoother; the femur is not tuberculated on the inner side. But a closer examination of many young and old specimens from the South shows so many analogous forms, that it is impossible, at least as yet, to separate them with certainty. But I confess that they seem, in many respects, to belong to a different species (viz. *C. Blandingii*). Long. corp. 3 ad 4 inch.

Mas maximus long. corp. 6.3; antenn. 5.1; ped. ant. 6.2; chelæ, 3.9.

Patria: New Orleans and Milliken's Bend, Louisiana; Mobile; Charleston, South Carolina; St. Louis, Mississippi bottom; James River, Virginia (Mus. Philad.); Mobile River; Kemper Co., Mississippi (Mus. Philad.).

Var. A. Lawn Ridge, Basson Ridge, Evanston, and Peoria, Illinois; Indiana (Mus. Salem).

Var. B. New Jersey; New York; Beaufort, North Carolina.

Vidi specimina plurima, adulta et juniora.

I have not seen the type of *C. acutus* Gir., but I have no doubt that it is the first form of the species described above. The Museum of Philadelphia possesses two young dry second-form males, labelled "C. acutissimus *Gir.*?" from Kemper Co., Mississippi, the locality mentioned by Mr. Girard for the type. There is no doubt that these males are the young of the species above described, and I think also the veritable *C. acutissimus* Gir., l. c. T. 6, p. 91.

Cambarus acutus is the largest North American species. The most important characters are: the rostrum is one and a half times as long as broad, with a distinct large impression, surrounded by a little elevated part at the base; the thorax is strongly tuberculated, posteriorly dilated, without lateral spine; the areola is impressed, very little carinated in the middle; the external lobes of the two penultimate segments of the postabdomen with the external posterior angle finished in a sharp right angle; the lamina in the middle of the apex is large, the basal part longer than the apical, the terminal margin of which is not very deeply excised in the middle. The antennæ are as long as the body, or longer; their lamina much enlarged in the middle; the external maxillary legs always barbate; the epistoma is transversely elliptical, rounded in front; the anterior legs are very long; the brachium is longer than the rostrum; the hand has large and flat tubercles, which in front are a little hairy; the external margin of the hand and finger is straight; the internal margin nearly straight, strongly denticulated; the mobile finger is sinuated, a little longer than the exterior; the brachium is tuberculated above and inside near the carpus. The female has the venter between the fourth legs behind bi- or bisbituberculated, and a larger flat tubercle near the third legs.

The four species, *C. acutus, C. Clarkii, C. troglodytes, and C. Blandingii*

are very similar in size and forms. For *C. Blandingii* see the description of this species. Of the three other species, the thorax is more ovoid, more dilated in *C. acutus;* laterally more compressed in *C. Clarkii;* between the two in *C. troglodytes*, nearly as dilated as in the first, but a little more depressed. The areola is the broadest, but very narrow in *C. acutus*, the narrowest and the most shallow in *C. Clarkii;* in both species the areola is posteriorly much more dilated than anteriorly; in *C. troglodytes* the areola is nearly as broad posteriorly as anteriorly. The thorax is strongly tuberculated in *C. acutus* and *C. Clarkii*, granulated in *C. troglodytes*. The rostrum is most sinuated, and often clearly dentated in *C. Clarkii;* less sinuated and dentated in *C. troglodytes*. The rostrum is nearly plain in *C. troglodytes*, most excavated, with the margins more elevated, in *C. Clarkii; C. acutus* is intermediate. The base of the rostrum shows a different structure, but a little obscure. There is in *C. acutus* and *C. Clarkii* a circular depression, terminated in front by a somewhat rounded elevation in *C. acutus;* in *C. Clarkii* by two oblique straight elevations, united in an obtuse angle; in *C. troglodytes* there is in the circular depression a very flat, central, round elevation or tubercle. The postabdomen is the narrowest and laterally most compressed in *C. Clarkii;* the apical part of the lamina is longer in *C. troglodytes* than in the other species. The hands are the shortest and broadest in *C. troglodytes;* the fingers nearly as long as the hands, in the other species much longer, in *C. Clarkii* they are deflected. The movable annulus in the female of *C. troglodytes* is striking; it is very firmly united with the venter between the fourth legs in the two other species.

Cat. No. 1161, New Orleans, La., L. Agassiz. Mas. Form I. Fem. Specimens, 12.*

Cat. No. 1843, New Orleans, La., L. Agassiz. Mas. very large. Form I. Spec. 1.

Cat. No. 1844, New Orleans, La., L. Agassiz. Mas. Form I. and II. Fem. Spec. 12.*

Cat. No. 1845, New Orleans, La., L. Agassiz. Mas. Form II.; first pair of abdominal legs articulated or not articulated. Spec. 12.*

Cat. No. 291, Mobile, Ala., L. Agassiz. Mas. Form I. and II. Fem. Spec. 12.*

Cat. No. 1846, Mobile, Ala., L. Agassiz. Mas. Form I. and II. Fem. var. thorace læviori. Spec. 12.*

Cat. No. 182, Charleston, S. C., L. Agassiz. Fem. Spec. 1.

Cat. No. 274, St. Louis, Mo., Dr. Engelmann. Mas. young. Spec. 1.

Cat. No. 151, St. Louis, Mississippi bottom, Dr. Engelmann. Mas. Form I. Fem. Spec. 6.

Var. A. Cat. No. 214. Lawn Ridge, Ill., Mr. O. Ordway. Mas. Form I. and II. Fem. Spec. 12.*

* The star signifies that the Museum possesses more than 12 specimens.

Cat. No. 1460, Evanston, Ill., Prof. O. Marcy. Mas. Form I. and II. Spec. 2.

Cat. No. 1820, Basson Pudge, Ill., Mr. Bulten. Mas. Form I. Spec. 1.

Var. B. Cat. No. 191, Essex, N. J. Fem. Spec. 3.

Cat. No. 292, New York. Fem. Spec. 1.

Cat. No. 1821, Beaufort, N. C., Mr. T. Shute. Fem. Spec. 2.

Dry Spec. Mobile, Ala., L. Agassiz. Male Form I. Spec. 1.

Peoria, Ill., Mr. O. Ordway. Male var. A., Form I. Spec. 2.

2. Cambarus Clarkii *Girard.*

Cambarus Clarkii Girard, Proc. Acad. Philad., T. 6, p. 91.

Figures on Pl. I., II., III., and IV

First abdominal leg of the male:

first form, fig. 7 in front; fig. 8 outside.

second form, fig. 9 in front; fig. 10 outside.

young, type of *C. Clarkii*, fig. 99 in front; fig. 100 outside.

development of the first abdominal leg in the young male 0.3 inch long, fig. 133.

more augmented, to show the structure of the knob, fig. 134.

Antennal lamina, fig. 137, *a*; epistoma, *b*; spine of the second joint of the exterior antennæ, *c*.

Tab. IV. mas., first form, New Orleans.

Mas. Rostro triangulari, lato, dimidio longiori, ante apicem acutum brevem utrinque sinuato vel subdentato, margine vix punctato lineato; supra lævi, excavato, basi foveola antice leviter triangulari; cretis basalibus extus sulcatis, apice extus acutis, fere parallelis, postice tuberculoso convergentibus. Antennis externis corpore æqualibus, articulis duobus basalibus dente externo brevi subacuto; antennis internis articulo basali dente infero medio acuto; lamina externa rostro longiori, articulo antennarum tertio æquali, lata, apice rotundata, margine externo inflato, apice brevi-spinoso. Epistomate brevi, duplo latiori, antice truncato, bisinuato, lateribus oblique productis, subsinuatis. Pedibus maxillaribus externis intus et subtus barbatis. Thorace utrinque subcompresso, densius tuberculato, cephalothorace supra lævi, parce punctato, postice obsolete bicalloso; linea profunda, modice sulcata, lateribus fissa, spina infera, ad antennarum basin apicali, acuta; areola angustissima, medio lineari, profunda, postice dilatata, triangulari, plana. Postabdomine lato, compresso, apice subangustiori, lævi, vix punctato, utrinque obsolete rubro, segmentis penultimis angulo externo postico obtuso; lamina media parte apicali vix breviori, basi subattenuata, apice subsinuata; parte basali apice sinuata, utrinque bispinosa. Pedibus anticis elongatis, longitudine corporis. Chela longa, crassiori, squamoso-tuberculata, margine interno longo, subincurvo, fortiter dentato; digitis chelæ longitudine, planioribus, apice subdeflexis, subsinuatis, apicibus acutis, incurvis, lævibus, intus apice spongiosis, basi subdentatis, digito externo tuberculo medio et basali intus majoribus; digito mobili sublongiori, basi intus exciso. Carpo longo, lævi, intus

tuberculato. spina media majori; subtus spinis duabus majoribus anticis. aliisque minoribus internis. Brachio rostro longiori. extus lævi. intus ante apicem et margine supero tuberculato. spinis duabus anteapicalibus oblique positis; subtus biseriatim spinoso. spinis internis apicalibus validis. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis et quintis capitulo basali. quartis oblongo-ovali. quintis compresso, laminato.

Pedibus abdominalibus brevibus. rectis. cylindricis. basi et ante apicem attenuatis. vix bifidis; parte externa margine postico dente medio obtuso. apice dentibus brevibus duabus compressis. corneis. latis. rotundato-incurvis; parte interna apice spina fusiformi, acuta.

Forma II. differt antennis chelisque brevioribus. unguiculis pedum minoribus; pedibus abdominalibus basi articulatis. minus attenuatis. parte externa apice fere obtuso. bituberculato. dentibus obscurioribus. nec fusco-corneis; parte interna spina conica breviori.

Mares formæ secundæ variant brachio rostro breviori, lateribus cephalothoracis minus tuberculatis; spina laterali ad lineam transversam (semper fere nulla in Forma I.); forma et latitudine rostri et acuminis variabili. vel marginibus rectis. vel subrotundatis; acumine basi distinctius dentato.

Femina differt antennis chelisque brevioribus. minoribus. minus tuberculatis; ventre inter pedes quartos nudo. non tuberculato: annulo ovali. obtuse conico. fissura longitudinali. labiis antice inflatis. sulcatis. fere bituberculatis.

Long. 3 and 4 unc. Mas maximus; long. 4.2; ped. ant. 4.7; antenn. 4.5; chelæ, 2.6.

Patria: New Orleans. Between San Antonio, Texas, and El Paso del Norte. Vidi specimina multa, adulta et juniora.

This species is very similar to *C. acutus*, but it differs surely; the rostrum is more evidently dentated before the acumen. and the obsolete impression at its base is terminated anteriorly by two oblique elevated lines; the epistoma is truncated and sinuated anteriorly and laterally; the thorax is laterally compressed. the areola linear in the middle; the penultimate segments of the postabdomen with the exterior angle are more obtuse; the apical part of the intermediate lamina is as long as the basal, a little attenuated at the base; the chelæ are shorter and broader; the legs of the postabdomen different; the venter of the fourth legs in the female is without tubercles. There is rarely one spine at the sides of the thorax.

C. Clarkii Girard. I have most carefully compared male and female types collected by the U. S. Mexican Boundary Commission. communicated by Professor Stimpson. They belong. without doubt. to this species. The male is a young specimen of the Forma II. (1.8 unc.

long); the female is smaller. The first abdominal leg of the male, figured by me after the type, shows exactly the shape of the male full-grown Forma II., but not as well finished as it is always found in the young specimens. I have not seen a similar young specimen from New Orleans; the smallest is 2.6 unc. long, but agrees very well. The young of *C. troglodytes*, of which I have seen specimens 0.6 unc. long, are very similar; but *C. Clarkii* differs in having the rostrum exactly triangular and a little attenuated at the tip (it is more dilated, with the margins curved, in *C. troglodytes*); the acumen is longer, more acute (in *C. Clarkii* type $\frac{5}{5}\frac{5}{0}$ unc. left side, $\frac{6}{5}\frac{6}{0}$ right side); the basis of the rostrum has two obsolete elevations connected in an obtuse angle; the lamina of the antennæ is more elongated, smaller at the tip.

In the Museum of the Natural History Society of Boston are two females, together with a great number of apparently very young animals, before described by me.

Cat. No. 1162, New Orleans, La., L. Agassiz. Mas. Form I. and II. Fem. Spec. 12.*

Cat. No. 166, New Orleans, La., L. Agassiz. Mas. Form I. Fem. Spec. 5.

Cat. No. 264, New Orleans, La., Mr. Allen. Mas. Fem., young. Spec. 3.

Cat. No. 1822, Mobile, Ala., L. Agassiz. Mas. Form II., young. Spec. 2.

3. Cambarus troglodytes *Le Conte.*

Astacus troglodytes LeC., Proc. Acad. Philad., T. 7, p. 400.

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 11 in front, fig. 12 outside.
second form, fig. 13 in front, fig. 14 outside.
Antennal lamina, fig. 141, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro triangulari, lato, tertia parte longiori, subdeflexo, ante apicem acutum, brevem, paulo barbatum, utrinque leviter sinuato; supra fere plano lævi, utrinque subtiliter marginato, tuberculo obsoleto plano in foveola basali orbiculari; cretis basalibus extus sulcatis, apice subacutis, subparallelis. Antennis gracilibus, corpore paulo brevioribus, articulis duobus basalibus dente externo parvo subacuto; antennis internis articulo basali dente infero medio acuto; lamina externa rostro longiori, articulo antennarum tertio vix breviori, lata, apice vix rotundata, margine externo inflato, apice brevi spinoso. Epistomate lato, antice et utrinque subsinuato (forma variabili, semper brevi, lateribus obliquis). Pedibus maxillaribus intus et basi subtus villosis. Thorace postice latiori, postice subdepresso, granuloso, cephalothorace medio fortius punctato, postice obsolete bicalloso, linea modice profunda et sinuata, lateribus fissa, spina infera ad antennarum basi apicali acuta; areola media angusta, subcarinata, postice latiori, transverse

impressa. Postabdomine subangustiori, lævi; segmentis penultimis angulo externo obtuso; lamina media parte apicali vix breviori, antice subrotundata; parte basali apice sinuata, utrinque bi-(vel tri)-spinosa. Pedibus anticis elongatis, corpore vix brevioribus; chela longa, crassiori, squamoso-tuberculata, margine interno longo, subrecto, densius tuberculato et fortiter dentato; digitis paulo longioribus, arcuatis, subcostatis, leviter punctato-lineatis, apicibus acutis, incurvis; intus apice squamosis, basi serratis; digito externo tuberculo medio et basali internis majoribus obtusis; digito mobili sublongiori, basi sinuata, tuberculo majori. Carpo longo, lævi, intus subtuberculato, spina media interna majori; subtus spinis duabus anticis majoribus. Brachio rostro longiori, extus lævi, intus ante apicem tuberculis nonnullis minoribus; margine superiori leviter tuberculoso, spinis duabus majoribus oblique positis; subtus biseriatim spinoso, spinis apicalibus validis. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis capitulo basali, latiori; quintis lamina quadrangulari, parva elevata. Pedibus abdominalibus brevibus, rectis, parte interna intus lata, plana, spina media posteriori, apice bifida; ramo antico brevi, fusiformi, acuto; ramo postico longiori, laminato compresso; parte externa cylindrica, valde bi-attenuata, dente apicali brevi, fusco corneo, triangulari.

Forma II. differt chelis brevioribus, unguiculis pedum minoribus; pedibus abdominalibus basi articulatis, parte interna ramo interno fere obtuso; parte externa dente apicali minori nec fusco corneo; spina thoracis laterali interdum distincta.

Femina differt antennis chelisque brevioribus, minoribus; ventre inter pedes tertios tuberculato, inter pedes quartos nudo; annulo obovali, fissura longitudinali, dentibus alternis, modice inflatis; annulo mobili, nec ventre præcedenti connato.

Long. 3. Mas maximus; long. 3.8; ped. ant. 3.7; antenn. 3.5.

Patria: Charleston, South Carolina; Lawn Ridge, Illinois; Rocky River, Olmsted, Ohio; Georgia.

(Habitat in Georgiæ oryzaceis, ubi spiracula 4 unc. alta format. LeConte.)

I have seen many very young specimens 0.6 inch long.

From Georgia I have seen but four specimens, two males (Forma I.), and two females. The first abdominal legs in the male are a little different in shape. The tip is more recurved, not straight as in the others. Apparently this is the veritable *A. troglodytes* LeC., and the intermediate lamina is always trispinose.

A. troglodytes male type LeConte (Mus. Philad.), with the dimensions given by Mr. LeConte, is identical with the males from Charleston. The abdominal legs are (Forma I.) similar; the lamina is trispinose.

The specimens before mentioned, from Georgia, are not essentially different, though the thorax is more compressed. The female has the areola larger. Some females from Charleston have the lamina also trispinose. It seems not prudent to separate the two species, for the materials are insufficient.

A single male, the largest seen by me, was in the same bottle with *A. obesus*, from Lawn Ridge, Illinois.

The posterior hooks of the abdominal legs of the male exist in the young males, Forma II.; in the very young they are sometimes absent; sometimes they disappear. The fingers are not arcuated in the younger male and female specimens.

A large female (dry), in the Cambridge Museum, communicated by L. R. Gibbes, as *A. Blandingii* Harl. from South Carolina, is *A. troglodytes*.

A. fossarum LeConte. A dry specimen (Mus. Philad.), a female, agreeing very well with the description, does not differ from *A. troglodytes*. It possesses the same compressed thorax, like the specimens from Georgia.

C. Blandingii (Mus. Philad.), from Charleston, is a male, Forma II., of *C. troglodytes*, and perhaps a type of *C. Blandingii* Girard.

Cat. No. 182, Charleston, S. C., L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 283, Charleston, S. C., Mr. Crady. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 197, Lawn Ridge, Illinois, Mr. O. Ordway. Male Form I. Spec. 1.

Cat. No. 1823, Georgia. Male Form I. and II. Fem. Spec. 4.

Dry spec. South Carolina, L. R. Gibbes. Male, labelled "*A. Blandingii*." Spec. 1.

Rocky River, Olmsted, Ohio, L. Agassiz. Male. Spec. 1.

Charleston, S. C., L. Agassiz. Male. Spec. 1.

4. Cambarus Blandingii *Harlan.*

Astacus Blandingii Harl, Trans. Amer. Philos. Soc., T. 3, p. 464. Harlan. Med. and Physic. Research, p. 229, fig. 1.

Figures on Pl. I. and III.

First abdominal legs of the male:

first form, fig. 63 in front, fig. 64 outside.

Antennal lamina fig. 140, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro triangulari, lato, lævi, excavato, marginibus summa basi parallelis, lineato-punctatis; acumine brevi, angusto, acuto, utrinque subsinuato; cretis basalibus validis, extus sulcatis, apice subacutis parallelis, postice calloso-convergentibus. Antennis validis, corpore brevioribus (? secundum Harlani figura), articulis duobus basalibus dente acuto externo; antennis internis articulo basali dente medio

infero; lamina rostro paulo longiori, pedunculo antennarum æquali, ante medium latiori, apice angusta, margine externo inflato, apice brevi-spinoso. Epistomate longitudine vix latiori, antice rotundato, lateribus obliquis, angulis lateralibus rectis. Pedibus maxillaribus intus et subtus barbatis. Thorace leviter ovali, grosso-punctato, lateribus granulosis; cephalothorace medio læviori, rarius punctato, postice bicalloso; linea ordinaria profunda, sinuata, utrinque fissa, spina laterali mediocri, spinaque infera apicali; areola angusta, profunda, postice paulo latiori, punctata. Postabdomine thorace vix angustiori, lævi, segmentis penultimis angulo externo postico recto; lamina media parte apicali vix breviori, margine apicali medio vix exciso; parte basali apice utrinque bispinosa. Pedibus anticis valde elongatis, subcylindricis; chela longa depresso-cylindrica, dense squamoso-tuberculata, margine interno longo recto, subdentato; digitis margine interno chelæ æqualibus, intus curvatis, gracilibus, carinatis, punctato-ciliatis, intus squamosis; digito interno paulo longiori; carpo longo, angusto, antice oblique truncato, intus tuberculato, spina interna media, aliaque antica minori, spinis duabus inferis anticis; brachio rostro longiori, extus lævi, intus ante apicem et margine supero tuberculato, spinis duabus anteapicalibus oblique positis. Subtus biseriatim spinoso, spina utrinque antica ad articulationem. Pedibus tertiis et quartis articulo tertio valde unguiculato; pedibus quartis capitulo basali ovali, compresso; quintis perbrevi, acuto. Pedibus abdominalibus validis, rectis; parte interna breviore, recta (dente apicali fracto); parte externa latiori, subcontorta, apice non angustiori; dentibus tribus fusco-corneis, medio longiori, antico lato, contorto, postico parvo, angusto, fere recto.

Long. corp. 3.8 inch; ped. ant. 3.9.

Patria: Camden, South Carolina (mas. Form I.)

I have only seen the type described and figured by Mr. Harlan, preserved dry in the Museum of the Philadelphia Academy, and labelled, "*A. Blandingii* Harlan. Camden, S. C., Dr. Blanding." Camden is situated in the mountains, but Mr. Harlan (in the Trans. Amer. Philos. Soc. l. c.) says: "All the crawfish which I have seen from the Southern States, and I have received specimens from New Orleans and South Carolina, are the same species with that now described." I have most carefully examined several hundred specimens from New Orleans and South Carolina, (the collection in the Museum of Cambridge being very rich for these localities,) but I have not found a single specimen of *C. Blandingii*. The description and the figure given by Mr. Harlan agree very well with his type; but the hand is no broader at the base than seen in the right hand of the figure. The hand is two inches long; the inner finger seems when open 0.1 inch longer than the external, it is as long as the hand, 1 inch.

Cambarus Clarkii and *C. troglodytes* are very similar, but instantly sepa-

rated since the epistoma is truncated at the tip. *C. Clarkii* differs in having the thorax strongly tuberculated, the areola linear or none; the base of the rostrum with two linear elevations joined in obtuse angle; the second article of the exterior antennæ, with the teeth shorter than its tubercle (as long as in *C. Blandingii* and very acute); the lamina is more enlarged at the tip; the hands broader, shorter, the fingers more arcuated and deflected, more tuberculated (one tubercule on the inside of the external finger in the middle in *C. Blandingii*); the abdominal legs differ also. *C. troglodytes* differs by the same characters.

C. acutus Gir. is very near in the shape and sculpture of the rostrum and epistoma, but the lamina is much larger at the tip; the teeth of the second article are shorter than the tubercle, the hands broader and shorter, the abdominal legs different. I have seen some hundred males of all sizes, but never a male with the abdominal legs analogous to *C. Blandingii*. The body is more tuberculated.

The females from Essex, New Jersey, quoted under *C. acutus* (but it is always difficult to identify females with males) are more similar, the body is not very strongly tuberculated, the lateral spine is evident, the lamina smaller at the tip.

C. LeContei is very near, but the abdominal legs are different; the shape of the hand is most similar, but the fingers are shorter and straight; the rostrum strongly dentated at the tip, the areola broad. The typical specimen of *C. Blandingii* is very well developed and it does not seem to me to be an abnormal specimen of *C. acutus* with abnormal hands, abdominal legs, and lamina. I cannot help regarding it a good species, perhaps (?) identical with the New Jersey females described provisionally as *C. acutus*.

It is not impossible that *C. Blandingii* LeConte, l. c. p. 400 (Georgiæ et Carolinæ regionibus intermediis), is this species, but in this the linea ordinaria is sulcated as in *C. troglodytes*, and not sulcated in *LeConte's* species. Erichson gives but a copy from Mr. Harlan's description.

C. Blandingii Gir., l. c. p. 91, without description, is probably *C. troglodytes*, which the Museum possesses from the same locality, Summerville, South Carolina, given by Mr. Girard. (Vide *C. Lecontei*.)

5. Cambarus Fallax *Hagen.*

Figures on Pl. I.
First abdominal leg of the male:
first form, fig. 103 in front, fig. 104 outside.
second form, fig. 105 inside.

Mas. Rostro elongato triangulari, lævi, excavato; acumine subacuto, ciliato, spina utrinque acuta; cretis basalibus validis, parallelis, extus vix sulcatis, apice acutis. Antennis gracilibus, corpore brevioribus, articulis duobus basalibus dente acuto externo; antennis internis

articulo basali dente medio infero; lamina rostro pedunculoque antennarum longiori, ante medium latiori, margine externo latius inflato, spina apicali acuta longiori. Epistomate lato, rotundato, antice medio subacuto; pedibus maxillaribus externis intus barbatis. Thorace angusto, compresso, punctato, lateribus scabris; linea profunda, sinuata, lateribus fissa; spina brevi valida, postice leviter barbata, aliaque infera acuta ad antennarum basin; areola plana, punctata, angusta, postice latiori. Postabdomine lato, compresso, thorace longiori, parcepunctato, segmentis penultimis angulo externo subrecto; lamina media parte basali quadrangulari, apice utrinque trispinosa; parte apicali æquali, apice angulis rotundatis. Pedibus anticis longis, gracilibus, angustis; chela elongata, angusta, depresso-cylindrica, leviter squamoso-tuberculata; margine interno longo, recto, subdentato; digitis paulo brevioribus, rectis, subcostatis, intus squamosis; digito mobili margine externo subdentato. Carpo longo, angusto, parce tuberculato, spina antica et media interna breviori; subtus spina antica externa; brachio longiori, sublævi, spinis duabus anteapicalibus oblique positis; subtus biseriatim spinoso, utrinque ad articulationem spina antica acuta. Pedibus secundis chela parce villosa; pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis et quintis capitulo basali, quartis oblongo majori, quintis compresso, triangulari, erecto. Pedibus abdominalibus validis, brevibus, rectis; parte externa spina anteapicali acuta, obliqua; parte externa dentibus perparvis fusco corneis adpressis.

Forma II., differt pedibus tertiis et quartis unguiculo minori; chela læviori; pedibus abdominalibus basi articulatis, parte interna spina anteapicali fortiori; parte externa apice rotundato; intus ad apicem fortiter sulcatis.

Femina junior differt chela brevi, minori; ventre inter pedes quartos lævi; annulo transversali, valido, fissura longitudinali antica recta, postica dentato-tuberculata.

Long. corp. 2.9; antenn. 2.4; ped. antic. 1.9.

Patria: Florida. Museum Boston Natural History Society.

I have seen only one male of each form (the male of the second form is even a little larger), and two very young females. This species is very near *C. LeConteï*, but differs in the longer thorax, the hands, and the abdominal legs. The legs, especially in the second form, are strongly sulcated on the inner side.

6. Cambarus LeConteI *Hagen.*

Figures on Pl. I. and III.
First abdominal leg of the male:
first form, fig. 15 in front; fig. 16 outside.
second form, fig. 17 in front; fig. 18 outside.
Antennal lamina, fig. 145, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro triangulari, lato, lævi, excavato, marginibus basi fere parallelis, lineato-ciliatis; acumine acuto, ciliato, utrinque spina acuta; cretis basalibus validis, parallelis, extus sulcatis, apice acutis. Antennis corporis fere longitudine, articulis duobus basalibus dente acuto externo; antennis internis articulo basali dente media infera; lamina rostro pedunculoque antennarum sublongiori, ante medium latiori, margine externo latius inflato, spina apicali breviori. Epistomate lato, antice rotundato, angulis externis fere rectis; pedibus maxillaribus externis intus barbatis. Thorace subcompresso, punctato-pubescente, lateribus scabris; linea profunda, vix sinuata, lateribus fissa, spina brevi valida, aliaque apicali infera acuta ad antennarum basin; areola angusta, plana, punctata, postice subito latiori, ante marginem thoracis posticum excisum transverso-impressa. Postabdomine lato, thorace longiori, parcepunctato, segmentis penultimis angulo externo rotundato; lamina media parte basali quadrangulari, apice utrinque tri-(vel quadri-) spinosa; parte apicali breviori, apice leviter emarginato. Pedibus anticis longis, gracilibus, angustis; chela longa, angusta, depresso-cylindrica, ubique squamoso-tuberculata, ciliata; margine interno longo, recto, subdentato; digitis paulo brevioribus, rectis, subcostatis, dense ciliatis, intus squamosis; digito externo dente medio interno minori. Carpo longo, angusto, leviter squamoso-tuberculato, spina antica interna et media majoribus; intus spinoso, spinis duabus anticis validis; brachio longiore, extus subl.evi, margine supero et intus ad apicem tuberculato, spinis duabus oblique positis anteapicalibus; subtus spinis nonnullis biseriatis; utrinque ad articulationem spina antica acuta. Pedibus secundis chela intus villosa; pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis et quintis capitulo basali, quartis oblongo, majori, quintis triangulari, compresso, erecto. Pedibus abdominalibus validis, brevibus, rectis, parte interna apice dente fusco corneo incurvo, spinaque anteapicali longiori transversali; parte externa, æquali, subcontorta medio crassiori, apice dentibus tribus incurvis acutis.

Forma II. differt pedibus tertiis et quartis unguiculo minori, chela angustiori, breviori fere lævi; pedibus abdominalibus basi articulatis, dentibus apicalibus non fusco corneis, condunatis, latioribus.

Femina differt chela breviori, obsolete tuberculosa; ventre inter pedes quartos apice bituberculato; annulo transversali, valido, fissura longitudinali, labiis alternatim crassioribus.

Long. corp. 3.8; antenn. 3.5; ped. antic. 3.2.

Patria: Mobile, Alabama; Pensacola, Florida; Beaufort, North Carolina; Milledgeville, Georgia; Root Pond, Mississippi; vidi 30 specimina.

I had previously considered this species as *C. angustulus* LeConte; but the type in the Philadelphia Museum is surely different (viz. *C. spiculifer*). This species is separated from the similar ones by the short mesothorax, the longer abdomen, and the long, small, and nearly cylindrical hands.

I consider *A. Blandingii* LeConte, l. c. T. 7, p. 400, as probably identical with *C. Lecontei*. The words "linea ordinaria non sulcata" do not agree very well; the transverse line is as sulcated as in *C. troglodytes*. The lamina of the postabdomen is bispinose in Mr. LeConte's species, trispinose in *C. Lecontei*. Still it seems probable that the two species are as likely to be identical with each other as with *C. Blandingii* Harlan.

Cat. No. 201 and 217, Mobile, Ala., L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 1824, Beaufort, N. C., Mr. T. Shute. Fem. Spec. 1.

Cat. No. 246, Milledgeville, Ga. Fem., and young. Spec. 4.

Cat. No. 307, Root Pond, Miss., Mr. Wailes. Male Form II. Spec. 1.

Cat. No. 249, Pensacola, Fla. Male, Fem., young. Spec. 3.

7. Cambarus spiculifer *LeConte.*

Astacus spiculifer LeConte, Proc. Acad. Philad., T. 7, p. 401.

Figures on Pl. I. and III.

First abdominal legs of the male:

first form, fig. 59 in front; fig. 60 outside.

second form, fig. 61 in front; fig. 52 outside.

Antennal lamina, fig. 147, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro longo, lævi, excavato, basi obsolete impresso, marginibus punctato-ciliatis, basi parallelis, deinde subconvergentibus; acumine longo, angusto, triangulari, acuto, utrinque spina breviori acuta; cretis validis, modice elevatis, parallelis, extus obsolete sulcatis, apice breviter acutis, postice obsolete inflatis, convergentibus. Antennis validis, corpore paululum brevioribus, articulis duobus basalibus dente externo acuto; antennis internis articulo basali dente medio infero acuto; lamina rostro fere longiori, medio latiori, apice angusta, margine externo latius inflato, spina modica acuta apicali. Epistomate lato, antice triangulari, angulis lateralibus rotundatis; pedibus maxillaribus externis intus barbatis. Thorace leviter ovato, punctato, lateribus leviter granulatis, vel partim tuberculosis; cephalothorace postice obsolete bicalloso; linea profunda, lateribus fissa, utrinque spinis duabus validis acutis; spina antica infera breviori ad antennarum basin; areola lata,

ad marginem anticum utrinque impressa, postice latiori, calloso-inflata; margine thoracis postico sinuato. Postabdomine thorace longiori, lato, subcompresso, parce-punctato, segmentis antepenultimis angulis lateralibus fere rectis; lamina media parte basali apice utrinque bispinosa (interdum trispinosa), parte apicali breviori, angulis rotundatis. Pedibus anticis longis, validis; chela longa, lata, subdepressa, ubique tuberculis majoribus obtusis, subtus rarioribus, margine interno subrecto, fortiter dentato; digitis vix brevioribus, planis, subcostatis, punctato-ciliatis; digito interno recto, sublongiore, utrinque dentato; externo incurvo, intus dentato, dente anteapicali majori. Carpo longo tuberculato, extus nudo, spina media interna valida; subtus spinis duabus apicalibus validis, intus bi-vel triseriatim spinoso; brachio longo, margine supero tuberculato, spinis duabus anteapicalibus acutis, subtus spinis biseriatis, anticis utrinque ad articulationem validis. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis et quintis capitulo basali, quartis ovato majori, quintis minori, laminato, erecto. Pedibus abdominalibus validis, apice paululum divisis, parte externa ante apicem angustiori, apice extus barbata, dentibus duobus fusco-corneis incurvis, supero longiori; parte interna fusiformi, apice spina longiori, gracili, subrecta, partem externam non superante.

Forma II. differt chelis minoribus, minus tuberculatis; unguiculis articuli tertii minoribus; pedibus abdominalibus basi articulatis, parte interna fortiori, spina apicali mobili, extus curvata; parte externa apice dentibus conicis, nec fusco-corneis, subincurvis; capitulo basali pedum posticorum minus expresso.

Femina differt antennis brevioribus, chela minori; ventre inter pedes quartos lævi, postice utrinque tuberculo compresso; annulo transverso, sulco antico longitudinali, lumine transverso, profundo, postico.

(Maxim.) Long. corp. 3.6; antenn. 3.3; ped. antic. 3.2.

Habitat: Athens, Georgia; Roswell, Georgia. Vidi multa specimina.

The females from Roswell differ a little in having the venter between the fourth legs not so much tuberculated, and the annulus less open. The males (Forma II.) seem to be identical.

I have seen the male type, Forma II., in the Mus. Philadelphia.

Cat. No. 172, Athens, Ga., Dr. J. LeConte. Male Form I., Fem. Spec. 12.*

Cat. No. 222, Roswell, Ga., Mr. N. A. Pratt. Male Form I., Fem. Spec. 5.

8. Cambarus angustatus *Le Conte.*

Astacus angustatus LeConte, Proc. Acad. Philad., T. 7, p. 401.

Figures on Pl. I. and III.
First abdominal legs of the male.
First form, fig. 65 in front, fig. 66 outside, fig. 67 inside.
Antennal lamina, fig. 146, *a*; epistoma, *b*; spine of the second joint of the exterior antennæ, *c*.

A little dry typical specimen, communicated to the Museum of the Philadelphia Academy by Mr. LeConte, is very difficult to identify with any specimen before me. It is a male (Forma I.), 1.95 inch long, hands 1.2 long, and agrees with the description. It seems to be a young male of *C. spiculifer* or a new species. The differences quoted in the descriptions of *C. spiculifer* and *C. angustatus* are not decisive. The rostrum in *C. angustatus* is described: "valde acuminatum, utrinque versus apicem fortiter et acute unidentatum"; in *C. spiculifer:* "longissime acuminatum, denticulo parvo utrinque ad acuminis basin." The two types show no difference, except that in *C. angustatus* the rostrum is not so narrow before the acumen. I have seen similar differences in *C. spiculifer*. *C. angustatus* is "linea ordinaria apice spina armata," but the same spine exists in *C. spiculifer*. The thorax has but one lateral spine (not at all noticed in the description), and two in *C. spiculifer*. But I have seen *C. spiculifer* with two, with three, and even with one spine. The lamina intermedia of the postabdomen has sometimes three apical spines in *C. spiculifer* as well as in *C. angustatus*. I should not hesitate to unite the two species (*C. spiculifer* as Forma II., and *C. angustatus* as Forma I. of the male), did I not find two differences not so easy to explain.

1. The hands are longer and narrower, not so tuberculated in *C. angustatus:* the fingers a little shorter than the hands, and inside always spongiose. I have seen hands nearly of the same shape in young *C. spiculifer*, but the fingers were always as long as the hands or longer, and not always spongiose, although sometimes a little so at the tip.

2. The first pair of abdominal legs are a little more obtuse at the tip, with the posterior border a little more dilated, and are sulcated on the inside. I confess that these differences are perhaps rather too minute, but the two together seem more important. I should expressly remark, that the type of *C. angustatus* seems well developed, and the hooks in the third and fourth legs strong. Finally, as Mr. John LeConte has seen and observed the species alive, and I have only two single specimens, I prefer to separate *C. angustatus;* a further examination may perhaps bring out more strongly the differences of the two nearly allied species.

"*C. angustatus* is found in Georgia inferiore, in aquæ puræ rivulos inter colliculos arenosos, *C. spiculifer* in Georgia superiore."

9. Cambarus versutus *Hagen.*

Figures on Pl. I. and III.
First abominal leg of the male:
first form, fig. 55 in front; fig. 56 outside.
second form, fig. 57 in front; fig. 58 outside.
Antennal lamina, fig. 150, *a*; epistoma, *b*; spine of the second joint of the exterior antennæ, *c*.

Mas. Rostro longo, lævi, excavato; marginibus nudis, basi fere parallelis, deinde subconvergentibus; acumine angusto triangulari, acuto, utrinque spina valida subrejecta; cretis basalibus validis, fere parallelis, extus sulcatis, apice spina acuta longiori. Antennis corporis fere longitudine, articulis duobus basalibus dente externo acuto longiori; antennis internis articulo basali dente medio infero longiori, acuto; lamina rostro pedunculoque antennarum longiori, media latiori, margine externo lato inflato, spina apicali longiori. Epistomate brevi, lato, antice obtuso triangulari, angulis lateralibus rotundatis; pedibus maxillaribus externis intus barbatis. Thorace fere cylindrico, lævi, utrinque antice subscabro; linea profunda, lateribus breviter fissa, spinis utrinque duabus validis, acutis; areola lata plana, antice posticeque latiori; margine thoracis postico exciso. Postabdomine thorace vix angustiori, paulo longiori, lævi, segmentis antepenultimis angulo externo subrecto; lamina media parte basali elongato-quadrangulari, apice utrinque tri-(interdum bi-vel quadri)-spinosa; parte apicali breviori, antice rotundata. Pedibus anticis modicis, gracilibus; chela angusta, media inflata, densius tuberculato-squamosa; margine interno subrecto, dentato; chela subtus læviori, ad marginem internum distincte sulcata; digitis chelæ longitudine, angustis, subcarinatis, subsinuatis, intus vix leviter serratis. Carpo longo, lævi, intus tuberculato, apice oblique truncato, spina antica et media internis acutis, longioribus; subtus spinis duabus anticis majoribus; brachio breviori, lævi, spinis duabus anteapicalibus oblique positis; subtus spinis validis biseriatis, utrinque ad articulationem spina antica acuta; pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis capitulo basali ovato, quintis minori laminato, erecto. Pedibus abdominalibus brevibus, modicis, partim intus ciliatis; parte interna cylindrica, spina anteapicali acuta; parte externa ante apicem angustiori, apice obtusiori, dentibus tribus internis fusco-corneis, incurvis.

Forma II., differt chelis angustioribus, depresso-cylindricis, rostro interdum magis triangulari; pedibus abdominalibus basi articulatis, apice obtusioribus, parte interna ante apicem angustiori, spina anteapicali transversali; parte externa apice obtuso, dentibus obsoletis, nec fusco-corneis; pedibus tertiis unguiculo minori.

Vidi marem majorem (Forma II.) pedibus abdominalibus basi non articulatis.

Femina differt chelis minoribus; ventre inter pedes quartos apice exciso, tuberculis conicis duobus apice approximatis; annulo transversali angusto, longitudinaliter fisso.

Maximus. Long corp. 2.6 – 3; antenn. 2.5 ; ped. antic. 2 – 2.5.

Patria: Spring Hill, Alabama; ten miles west of Mobile. — Vidi specimina multa.

Sometimes in the larger examples the thorax is more punctulated, and more granulated on the sides.

This species is very similar to *C. Lecontei*, but it differs in having a smaller and more parallel rostrum, a shorter mesothorax, twice as broad an areola, two spines on each side, somewhat shorter but broader hands, its inner margin slightly curved, sulcated beneath, the fingers a little curved, and the sexual parts.

C. versutus, spiculifer, Lecontei, and *angustatus* (if it be not identical with *C. spiculifer*) form a single group. The mesothorax is short; the abdomen a little longer than the thorax; the areola is broader; the lamina is longer than the pedunculus, and the rostrum long and slender; the spines of the antennal joints are well developed. Besides the differences taken from the sexual organs, *C. Lecontei* and *angustatus* have one lateral thoracic spine, while *C. spiculifer* and *versutus* have two lateral thoracic spines. *C. Lecontei* is separated by long and nearly cylindrical hands; *C. spiculifer*, by strongly tuberculated hands.

Cat. No. 190, Spring Hill, Ala., L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 1825, ten miles east from Mobile, Ala., L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

10. Cambarus maniculatus *LeConte.*

Astacus maniculatus LeConte, Proc. Acad. Philad., T. 7, p. 401.

I have not seen this species, which is described by Mr. LeConte as follows: —

Rostrum subplanum, vix concavum, obtusum cum acumine, versus apicem utrinque unidenticulatum. Lamina antennalis pedunculum æquans. Cephalothorax supra punctatus, lateribus sparsim granulosis. Areola suturalis angustissima, stria solum. Dorsum sicut in prioribus. Chela parva, angusta, tuberculato-punctata, margine interiore dentata, digiti recti, carinati, punctati. Carpus intus paucidentatus, dentibus tribus superioribus majoribus spiculæformibus. Brachium punctatum, latere superiore vix serrato, duabus tamen spinis brevibus anterioribus,

inferiore seriebus duabus spinularum. Lamellæ caudalis intermediæ pars anterior trispinosa.

Long. corp. 2.3 inch; antenn. 1.3; chelæ, 0.5.

Patria: Habitat cum priore (*C. fossarum*) in fossis Georgiæ inferioris.

The number of the hooked legs is not mentioned, and perhaps this species belongs to the group of *C. affinis*. The "areola suturalis angustissima, stria solum," is a very striking character, suggesting more or less agreement with *C. Clarkii*, *C. Wiegmanni*, *C. lancifer*, *C. obesus*, *C. adreus*, and *C. Carolinus*. *C. adreus* is otherwise described by LeConte; in *C. Carolinus*, *C. obesus*, and *C. Clarkii* the hands are different; in *C. lancifer* and *C. Wiegmanni* the rostrum differs.

11. Cambarus penicillatus *LeConte*.

Astacus penicillatus LeConte, Proc. Acad. Philad., T. 7, p. 401.

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 93 in front; fig. 94 outside.
second form, fig. 95 in front; 96 outside.
Antennal lamina, fig. 149, *a*; epistome, *b*; spine of the second joint of the exterior antennæ, *c*.

Mas. Rostro lato, longo, plano, lævi, apice subdeflexo, marginibus ad acuminis brevis acuti apicem elevatis, convergentibus, antice subito incurvis; cretis vix elevatis, subparallelis, lineato-impressis, muticis. Antennis modicis corpore brevioribus; articulis basalibus duobus dente parvo externo; antennis internis articulo basali dente infero submarginali; lamina brevi, lata, apice fere truncata, margine externo inflato, spina apicali acuta. Epistomate brevi, lato, antice obtuse-triangulari; pedibus maxillaribus externis intus et subtus barbatis. Thorace cylindrico, compresso, punctato, lateribus granuloso; linea modice profunda, subsinuata, lateribus divisa, apice mutica; areola punctata, modica, postice valde dilatata. Postabdomine thoracis longitudine ac latitudine, lateraliter compresso; lamina media parte basali apice utrinque bispina, parte apicali elliptica, vix breviori; segmentis anteapicalibus angulis externis posticis obtusis, rotundatis. Pedibus anticis modicis; chela, latiuscula, punctato-granulosa, margine interno recto, serrato, longe barbato; digitis chelæ æqualibus, rectis, costatis, punctato-ciliatis, intus spongiosis, digito mobili basi extus serrato. Carpo parcepunctato, longiore, extus oblique truncato, margine interno serrato, spina media majori; subtus læviori, spina antica media. Brachio lævi, spinis anteapicalibus parvis; subtus biseriatim spinoso. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis capitulo basali conico, quintis spina basali obtusa. Pedibus abdominalibus rectis, brevibus, apice contortis, subtus medio excisis, apice fere coadunatis; parte in-

terna dente apicali acuto erecto; parte externa apice incurva, internam tegente, dentibus duabus apicalibus corneis perparvis, coadunatis.

Forma II. differt chela non barbata; pedibus abdominalibus magis cylindricis, basi articulatis, parte interna dente apicali extrorsum recurvo, parte externa dentibus non fusco corneis, majoribus, distantibus.

Femina differt chelis minoribus; ventre inter pedes quartos lævi, annulo majori, ovali, sulco longitudinali, alternatim fisso.

Long. 1.8; antenn. 1.3; ped. ant. 1.2.

Habitat: Georgia; Charleston, South Carolina.

Animal paulo villosum. Vidi juniores rostro acutiori, ante apicem utrinque dente acuto, pedibus maris abdominalibus dentibus magis expressis.

The description of *C. penicillatus* LeConte differs somewhat. The words, "Thorax lateribus granulatis," "brachio punctato, spinoso, tuberculato," do not answer very well to the single male, Forma I., which I have seen. But I think the species the same. The tuft of hairs along the inner margin of the hand is very striking.

Cat. No. 250, Charleston, S. C., L. Agassiz. Male, female, young. Spec. 8.

Cat. No. 254, Charleston, S. C., Professor Baird. Male Form I. Fem. Spec. 2.

Cat. No. 279, Georgia, Dr. Jones. Male, young. Spec. 1.

12. Cambarus Wiegmanni *Erichson.*

Astacus Wiegmanni Erichson, Wiegm. Arch., T. 12, p. 99, n. 19.

Figures on Pl. III.
Antennal lamina, fig. 151, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Fem. Rostro lato, modice longo, articulum antennarum secundum vix superanti, plano, punctato, antice sensim angustiori, acumine subito ac breviter triangulari, latitudine fere dimidio breviori; marginibus usque ad apicem elevatis; cretis modice elevatis, postice divergentibus, extus obsolete lineato-impressis, antice muticis. Antennis validioribus, corpore brevioribus; articulis basalibus dente parvo externo; antennis internis dente infero medio acuto; lamina brevi, antice latissima, margine externo inflato, spina apicali brevi, acuta. Epistomate brevi, lato, antice triangulari, acutiori; pedibus maxillaribus intus dense, subtus minus barbatis. Thorace elongato ovato, ubique punctato, lateribus mesothoracis granulosis; linea modica profunda, subsinuata, lateribus divisa, apice mutica; areola punctata, angusta, postice subito latiori. Postabdomine thoracis longitudine, basi thorace latiori, subcompresso, lævi, postice angustiori; segmentis anteapicalibus angulis externis obtusis, subrotundatis; lamina media parte basali apice utrinque bispina

parte apicali antice rotundata (? margo deest). Pedibus anticis modicis, dense squamoso-tuberculatis; chela latiuscula, modice inflata, ubique squamoso-tuberculata, margine interno recto serrato; digitis validis, rectis, costatis et punctato-lineatis, extus squamoso-tuberculatis, intus dentatis, tuberculis basalibus validioribus. Carpo squamoso-tuberculato, margine interno dentato; subtus spinis duabus anticis. Brachio lævi, supra et antice tuberculato, subtus biseriatim dentato. Ventre inter pedes quartos nudo, annulo majori, obovato, indiviso, antice subexciso, medio transverso-elevato, postice depresso.

Long. 2.6; antenn. ; ped. ant. 1.7.

Hab.: Mexico. Acad. N. Sc. Philadelphia.

I have seen only one female, which was found by Mr. Pease. Professor Erichson has described a little smaller male (two inches long); the description agrees very well. Erichson remarks that the third pair of legs and the fourth possess a hook.

This species is apparently of the same group as *C. penicillatus*. It differs in the strongly tuberculated hands, the much enlarged lamina of the antennæ, and the small areola. This species and *A. pellucidus* have the lamina of the antennæ most dilated near the tip, all other species of this group have the greatest dilatation behind the middle and nearer the base.

Cambarus Azteeus Saussure, Revue et Magas., T. 9, p. 503, and Mém. Soc. Phys. Genève, T. 14, P. II. p. 460, fig. 23, from Tomatlan (ruisseaux dans les Terres-Chaudes), seems to be identical with *C. Wiegmanni*, at least with the female described by me.

13. Cambarus pellucidus *Tellkampf.*

Astacus pellucidus Tellkampf, Mueller Archiv. 1844, p. 383. — Erichson, Wiegm. Archiv., T. 12, p. 95, n. 14.

Figures on Pl. I., III., and VI.
First abdominal legs of the male:
first form, fig. 68 in front, fig. 69 outside.
second form, fig. 70 in front, fig. 71 outside.
Antennal lamina, fig. 148, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro lato, longo, lævi, subexcavato, foveola basali, latiori, marginibus modice elevatis, subconvergentibus, utrinque valde excisis, spina valida, acuta, subrejecta; acumine longo, angusto, acuto; cretis perparvis, fere parallelis, extus impressis, antice spina valida acuta. Antennis corpore longioribus, articulis duobus basalibus dente externo valido; articulo basali internarum dente infero subapicali acuto; lamina rostro fere longitudine, sat lata, ante apicem latiori; margine externo paulo rotundato, inflato, spina apicali acuta. Epistomate brevi, lato, subexcavato basi vix angustiori obtuse triangulari, dente medio antico interdum producto. Pedibus maxillaribus externis intus barbatis.

Thorace fere cylindrico; mesothorace longiori, postice paulo angustiori; parce punctato, lævi, lateribus subgranulosis; cephalothorace utrinque spinis nonnullis acutis; linea profunda, non sinuata, serie postica spinarum acutarum, spinaque acuta antica infera ad antennarum basin; areola sat lata, plana, lævi. Postabdomine latitudine thoracis, compresso, lævi, apice non angustiori, angulis segmentorum externis rectis; lamina media parte apicali longa elliptica, parte basali apice utrinque bispinosa. Pedibus anticis longis gracilibus, chela longa, angusta, depresso-cylindrica, subpunctata, margine interno longo, recto, dentato; margine externo subdentato; digitis vix longioribus, rectis, gracilibus, subcostatis, basi subdentatis. Carpo longo, subcylindrico, intus tuberculato, spina media acuta; subtus spinis duabus anticis acutis, serie interna tuberculosa. Brachio longo, margine supero tuberculoso, spinis duabus anteapicalibus, oblique positis; subtus spinis acutis biseriatis. Pedibus tertiis et quartis articulo tertio unguiculato; pedibus quartis capitulo basali compresso, dilatato. Pedibus abdominalibus modicis, rectis, apice contortis; parte interna fortiori, cylindrica, apice membranacea, triangulari, acuta, subincurva; parte externa vix breviori, apice cornea, subrecurva, triangulari. Oculis occultis, cornea parva, indivisa.

Forma II. Pedibus abdominalibus basi articulatis, similibus, apice obtusis, nec corneis.

Femina differt chelis minoribus; ventre inter pedes quartos nudo, annulo rotundato, clauso, medio carinato.

Long. corp. 2.6 and 3.2; antenn. 3.2 and 3.4; ped. ant. 2.1.

Hab.: Mammoth Cave, Kentucky.

I have seen thirty-eight specimens, old and young.

The Museum possesses a full-grown female of *C. Bartonii*, with the eyes well developed, found in the Mammoth Cave.

I have given the peculiarities of this abnormal species in the introduction to this genus. I remark that in the second-form males the abdominal legs are often not articulated, and that the hooks on the third and the fourth set of legs are less developed. I have seen a few specimens with the hooks on the fourth pair of legs much less developed; in one specimen, even, they are entirely wanting. This observation justifies me, perhaps, in placing *C. pellucidus* as the last species of this group, and as somewhat allied to the following group of *C. affinis*.

Cat. No. 193, Mammoth Cave, Kentucky. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 225, Mammoth Cave, Kentucky, Professor Baird. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 1826, Mammoth Cave, Kentucky. Male. Fem. Spec. 5.

Cat. No. 1827, Mammoth Cave, Kentucky. Male, very large. Spec. 1.

Dry Spec. Mammoth Cave, Kentucky. Male. Fem. Spec. 2.

II. GROUP. (Type, C. affinis.)

The third legs of the males hooked; rostrum subquadrangularly elongated, with an antapical tooth on each side, at least in the young; first pair of abdominal legs bifid, elongated, straight and acute at the tip.

This group seems very natural, if we except two abnormal species, *C. immunis* and *C. extraneus*. *C. lucifer* is to be considered in some degree as an exaggerated form of this group.

Well-developed hooks always appear on the third pair of legs of the male; on the fourth pair they are never to be found; in very rare instances the second pair shows similar incipient hooks more largely developed (as in *C. virilis*).

The rostrum is exceedingly long, more than three times longer than broad, in *C. lucifer*. In all the other species the rostrum is twice, or less than twice as long as broad, of a more subquadrangular form; excavated, the margins thickened and parallel (*C. affinis*), or concave on the sides (*C. juvenilis* and *C. placidus*), or flattened, more or less straight on the sides, in the other species. The apical tooth and the two lateral teeth are all well developed, at least in the young. In *C. immunis* alone the shape of the rostrum is very different in the full-grown species. The rostrum is conical, short, and toothless, as in the third group (*C. Bartonii*); nevertheless, according to the form of the abdominal legs, it belongs to the group of *C. affinis*.

The foreborder of the cephalothorax is strongly angulated behind the antennæ in *C. lucifer*, *C. extraneus*, *C. immunis*, and *C. affinis*, straight or slightly notched in all the other species. This character serves to separate the species otherwise related to *C. affinis* into two sections of equal value.

The first pair of abdominal legs is always strongly bifid, the tips much elongated and acute. In *C. lucifer*, while the tips are not so much elongated, they are somewhat flattened, but apparently of the shape characteristic of this group. A remarkable exception is to be found in *C. extraneus*, which has the first pair of abdominal legs of the shape peculiar to the third group (*C. Bartonii*); but the rostrum and other characters prevent me from placing them otherwise than in the group of *C. affinis*.

The body and the hands in the species of the second group are shorter and broader, except in *C. lucifer*, which more nearly resembles the species of the first group. The flagellum of the inner antennæ has the internal branch visibly narrower, and sometimes even a little shorter, than the external branch. The lamina of the antennæ is smaller, shorter, and dilated in the middle, except in *C. lucifer*, the lamina of which has exactly the form described in the first group. The epistoma

is mostly truncated before in front. The basal joint of the inner antennæ has a spine beneath, in the middle, or nearer the tip.

As yet burrowing habits have not been observed in the species belonging to this group. But perhaps *C. obscurus* is identical with *Astacus fossor* Rafinesque, which burrows in meadows and milldams.

The species contained in this group are divided into four sections, or perhaps they more fitly form one natural group and three abnormal or exaggerated species, which may be described in the following terms: —

1. The rostrum is very long and acute; the lamina of the antennæ elongated, dilated near the base; the hands are narrow and elongated; the first abdominal legs somewhat flattened at the tip. (*C. lancifer.*)

2. The rostrum is more subquadrangular; the lamina of the antennæ small, short, dilated in the middle; the hands are shorter and broader; the first abdominal legs acute at the tip. (*C. affinis* and allied species.)

3. The rostrum is short, conical, toothless; the other characters are as in the foregoing groups. (*C. immunis.*)

4. Characters as in the groups of *C. affinis*, but the first abdominal legs recurved at their extremity, the tip of which is rounded (as in *C. Bartonii*).

Synopsis of the Species.

1st Section.

1. *C. lancifer.*

2d Section.

2. *A.* The margins of the excavated rostrum thickened.
   - *a.* The margins straight, front border of the cephalothorax angulated: *C. affinis.*
   - *b.* The margins concave, front border of the cephalothorax not angulated: *C. juvenilis* and *C. placidus.*

   B. The margins of the flattened rostrum not thickened, front border of the cephalothorax not angulated.
   - *a.* The rostrum carinated at the tip: *C. propinquus.*
   - *b.* The rostrum not carinated: *C. virilis, C. rusticus, C. obscurus.*

3d Section.

3. *C. immunis.*

4th Section.

4. *C. extraneus.*

I have already mentioned that the species more closely related to *C. affinis* are separated into two sections, one with the front border of the cephalothorax angulated. — *C. affinis, C. lancifer, C. immunis, C. extraneus;* the second with the front border straight or slightly notched. — *C. juvenilis, C. placidus, C. propinquus, C. virilis, C. rusticus, C. obscurus.* The latter section is very natural, and perhaps it would be preferable to follow this arrangement in the separation of the species described.

14. Cambarus lancifer *Hagen.*

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 86 in front; fig. 87 outside.
Antennal lamina, fig. 159, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro lato, longo, lævi, profunde excavato, longissime acuminato, marginibus parallelis, ad acuminis apicem ciliatis; acumine rostro longiori, angusto, acuto, recto, antennarum pedunculo longiori, basi utrinque spina valida; cretis basalibus rostro coadunatis parallelis, modicis conicis, extus vix sulcatis, apice acutis. Antennis corpore paulo brevioribus, gracilibus, articulis basalibus elongatis, articulo primo dente externo longiori, acuto, articulo secundo dente parvo acuto; antennis internis articulo basali dente medio infero acuto. Lamina longa, rostro æquali, angusta, ante medium latiori, deinde sensim attenuata, margine externo sinuato, inflato, apice acuto. Epistomate brevi, lato, antice obtuso-triangulari, angulis lateralibus rotundatis. Pedibus maxillaribus intus barbatis. Thorace cylindrico, cephalothorace supra longiori, lævi, sub-pubescente; linea profunda, non sulcata, lateribus fissa, spina valida, acuta, intus barbata; spina antica infera ad antennarum basin parva; areola media nulla, antice spatio triangulari parvo, postice majori plana. Postabdomine thoracis latitudine, subtiliter punctato, segmentis antepenultimis angulo externo acutiori; lamina media parte apicali breviori, antice leviter rotundata, media subsinuata; parte basali apice utrinque spina unica valida. Pedibus anticis longis, gracilibus, depresso-cylindricis, subpubescentibus; chela longa, angusta, subdepressa, marginibus parallelis, interno longo, recto; digitis brevioribus, rectis, intus squamosis; carpo longo, leviter oblique truncato, spina interna antica brevi, acuta; subtus spina antica externa valida, acuta; brachio longo, spina anteapicali acuta; subtus spina interna antica, aliaque externa media brevioribus. Pedibus tertiis articulo tertio unguiculato; pedibus quartis tuberculo perparvo basali, quintis capitulo basali annulari. Pedibus abdominalibus brevibus, validis, apice bifidis, contortis; parte interna cylindrica, apice subito subangustiori, extus curva, laminata, obtusa; parte externa fortiori, apice subito subangustiori, fusco cornea, intus curva, laminata, obtusa.

Long. corp. 2.8; antenn. 2; ped. antic. 2.

Patria: Root Pond, Mississippi.

Species valde insignis; vidi marem unicum, Forma I., pedibus abdominalibus basi non articulatis, apice fusco corneis, rostro acumine longissimo.

Cat. No. 306, Root Pond, Miss., Mr. Wailes. Male Form I. Spec. 1.

15. Cambarus affinis *Say.*

Astacus affinis Say, Journ. Philad. Acad., T. 1, p. 168, n. 3. — Harlan., Med. Physic. Researches, p. 230, fig. 2.

Figures on Pl. I., III., and V.
First abdominal legs of the male (full-grown *C. Pealei*):
first form, fig. 84 in front, fig. 85 outside.
Common size:
first form, fig. 19 in front, fig. 20 outside.
second form, fig. 21 in front, fig. 22 outside.
Antennal lamina, fig. 152, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.
Pl. V. Full-grown female (*C. Pealei*) from Maryland, Havre de Grace.

Mas. Corpore pubescente; rostro lato, parallelo, basi media late excavata, utrinque ad marginem linea impressa, ciliata; acumine angusto, triangulari, acuto, parti dilatatæ fere æquali, marginato, apice subrecurvo, basi utrinque spina acuta longiori; cretis validis, extus sulcatis, parallelis, spina apicali longiori. Antennis validis thoracis longitudine; articulis duobus basalibus dente externo acuto longiori; antennis internis articulo basali dente infero medio acuto longiori; lamina longa, rostri longitudine, lata ad apicem attenuata, margine externo late inflato, spina apicali valida. Epistomate lato cliptico, basi angustiori. Pedibus maxillaribus externis intus, basi subtus villosis. Thorace ovoideo, punctato-pubescente, lateribus leviter, antice magis granulosis; cephalothoracis lateribus spinis nonnullis minoribus; linea profunda, vix sinuata, utrinque fissa, spina acuta, valida; spina apicali, infera, acuta; areola modica, plana, antice posticeque æque latiori. Postabdomine thorace longiori, lato, fere lævi, segmentis penultimis angulis externis subrectis; lamina media parte apicali breviori rotundata; parte basali utrinque apice bispina; lamina laterali usque ad marginem costata; lamina externa toto margine intermedio dentato. Pedibus anticis brevibus, chela brevi, angusta, depressa, punctato-ciliata, margine interno subrecto, serrato, margine externo lineato; digitis paulo longioribus, rectis, subcostatis, margine interno recto, spongioso; chela subtus parce punctata, digitis magis ciliatis. Carpo longo, oblique truncato, punctato-ciliato, spina media aliaque antica minori, internis acutis; subtus spinis duabus acutis validis. Brachio brevi, lævi, spinis duabus anteapicalibus acutis validis, oblique positis; subtus spinis nonnullis validis, acutis, biseriatis. Pedibus tertiis articulo tertio articulato; pedibus quintis capitulo basali annulari. Pedibus abdominalibus, brevibus, validis, rectis, subcontortis, apice breviter bifidis; parte interna cylindrica, apice cornea, laminata; parte externa æquali, apice recurva, cornea, acuta.

Forma II. differt pedibus abdominalibus basi articulatis, apicibus nec fusco corneis, parte interna conica, acutiori, externa obtusiori recurva.

Femina differt ventre inter pedes quartos lævi; annulo obovato,

valido, lumine postico transversali, sulco antico longitudinali, fere bituberculato.

Long. corp. 3; antenn. 1.4; ped. antic. 1.9.

Very old specimens: Long. corp. 4.7; antenn. 2.8; ped. ant. 3.5.

Patria: Reading, Schuylkill River, Philadelphia; Pittsburg, Pennsylvania; New Jersey. Many very young specimens from the Niagara and Lake Erie. The very old specimens from New York; Havre de Grace, Maryland; from the Potomac at Washington; Carlisle, Pennsylvania.

The abdominal legs of the first form of the male vary a little in the shape of the interior tip, which is more or less acute. I have figured both; the more acute one is taken from the largest specimens, but it is also found in the younger. The obtuse tip is figured from one of intermediate age.

The young are similar to *A. propinquus* (*vide* that species).

The full-grown and very old specimens, described by Mr. Girard as *Cambarus Pealei*, differ in the following points:—

Mas. Corpore densius punctato-pubescente; rostro latitudine duplo longiori, leviter excavato, basi foveola lata, profundiori; marginibus lateralibus inflatis, spinis anteapicalibus validis, subrejectis; lamina antennarum margine externo subsinuato. Epistomate brevi, lato, antice obtuso-rotundato, angulis lateralibus acutioribus. Thorace lateribus magis granuloso; cephalothoracis spinis acutioribus; linea profunda, utrinque fissa, spina duplici valida acuta aliisque minoribus; spina antica infera rejecta; areola punctato-ciliata. Pedibus anticis validis; chela forte ciliato-punctata, margine interno subincurvo, dentato, supra et subtus sulcato, digitis vix longioribus, planis, intus et digito mobili extus dentatis; carpo spina interna media valida; brachio spinis nonnullis anteapicalibus, nonnullisque minoribus anticis, omnibus acutis; subtus utrinque spina ad articulationem valida. Annulo feminæ utrinque tuberculo ad sulcum longitudinalem valido.

Six very old and full-grown specimens from Havre de Grace, Maryland, agree so very well with the description given by Mr. Thomas Say, that they are doubtless *Astacus affinis* Say. A full-grown male from the Potomac, communicated by the Philadelphia Academy and labelled "*C. Pealei* Girard?" is identical with the specimens from Havre de Grace. Girard's species was from the Potomac, and "the fingers fasciate with green near the tips" are also described by Mr. Thomas Say. I have seen male and female from Reading, Schuylkill River, collected by Professor Baird, labelled as *C. affinis* Girard, and communicated as types from the Smithsonian collection by Professor W. Stimpson. The male belongs to the second form; the specimens are young, with only one lateral thoracic spine; in other respects they do not differ. I have no doubt that they are young of the species described above; Mr. Gi-

rard's description of *C. affinis* being made from specimens from Reading, and of *C. Pealei* from those of the Potomac, he was perhaps induced by this difference (though he does not say so) to refer the individuals to two species. The other differences given by him, namely, the longer antennæ, the broader area, the much less developed lateral spine of the rostrum, have no decisive value.

The *Astacus limosus* Rafinesque, Amer. Monthl. Mag., T. 2, p. 42, from the muddy banks of the Delaware, is apparently the same species, as quoted before by Mr. Girard. Rafinesque describes "a thorn of each flank" and gives the extreme dimensions "three to nine inches." I have seen specimens three inches long with only one thorn upon a side, and I have no doubt about their identity. The largest specimen seen by me is about five inches long. Nearly all younger specimens (three inches long) are bearded at their articulations, as quoted by Rafinesque; the larger specimens show much less hair. The description of *A. limosus* was published in November, 1817, of *A. affinis* in December, 1817, one month later. But the description of *A. affinis* is so perfect, that of *A. limosus* so imperfect, that it would be more suitable to retain the name given by Mr. Thomas Say, although the other has the priority.

The identity of *A. affinis* Erichs., Wiegm. Archiv, T. 12, p. 96, n. 15, is probable. His description contains no different indication, but gives no security. *A. Bartonii* Milne Edw., Hist. Crust., T. 2, p. 331, n. 2, is apparently *C. affinis*. The typographical error in the quotation of the figures by Mr. Harlan has misled Mr. Milne Edwards, as Erichson remarks. The types of *A. Bartonii* Gibbes, in the Philadelphia Academy, are *C. affinis*.

Cat. No. 164, Havre de Grace, Md., Mr. T. R. Williams. Male Form I. Fem. Spec. 4.

Cat. No. 180, Havre de Grace, Md., Mr. T. R. Williams. Male Form I. Spec. 2.

Cat. No. 163, New Jersey, Mr. Abry. Male. Fem., young. Spec. 3.

Cat. No. 162, Schuylkill River, Pa., Mr. J. H. R. Male. Fem., young. Spec. 6.

Cat. No. 179, Niagara, N. Y., L. Agassiz. Male. Fem., young. Spec. 12.*

Cat. No. 177, Carlisle, Pa. Male. Fem., young. Spec. 2.

Cat. No. 270, New York, Mr. Pike. Fem. Spec. 1.

16. Cambarus virilis *Hagen.*

Figures on Pl. I., II., III., and VIII.
Antennal lamina, fig. 155, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.
First abdominal legs of the male:
first form, fig. 23 in front; fig. 24 outside; figs. 25, 26 variety, outside.
second form, fig. 27 in front; fig. 28 outside.
Inner sexual parts of the male:
first form, figs 128, 129 side; fig. 132 viewed more from above.
second form, figs. 130, 131 side.
Pl. VIII. Male, first form: *a* variety A.

Mas. Rostro lato, fere duplo longiori, subexcavato, marginibus parallelis, antice vix convergentibus, punctato-lineatis; ante apicem utrinque subito sinuato, acumine triangulari, acuto, rostri latitudine non longiori, angusto, angulo basali laterali corneo, obtuso vel subacuto; cretis basalibus extus sulcatis, parum elevatis, parallelis, antice truncatis, subacutis. Antennis corpore brevioribus, articulis duobus basalibus dente externo, parvo, subacuto; antennis internis articulo basali dente infero medio acuto interno; lamina rostri longitudine, lata, margine externo inflato, apice brevi spinoso. Epistomate longitudine dimidio latiori, antice truncato, angustiori, acumine medio brevi, lateribus obliquis, subexcavato. (Forma epistomatis variabili, antice lateribusque margine vel recto, vel sinuato, vel exciso; angulis obtusis vel rotundatis.) Pedibus maxillaribus externis intus et subtus villosis. Thorace leviter ovato, subdepresso, parce sed distincte punctato, lateribus scabris, cephalothorace medio fere lævi; linea profunda modice sinuata, utrinque fissa, spina brevi, valida; spina antica infera submulla; areola plana, punctata, medio angusta, postice magis dilatata. Postabdomine lato, thoracis longitudine, parcepunctato, segmentis penultimis angulo externo obtuso; lamina media parte apicali breviori, angulis rotundatis; parte basali apice sinuata, utrinque spinis duabus validis. Pedibus anticis brevibus, validis; chela lata, planiori, obsolete punctata, intus tuberculis biseriatis dentata; digitis dimidio longioribus, latis, planis, costato-lineatis, fortiter punctatis; interno recto, basi extus et intus tuberculoso-dentato; externo basi margine interno tuberculoso, subtus barbato, margine externo lævi, apice subincurvo; carpo latitudine vix longiori, extus oblique truncato, sublævi, spina interna media majori, aliaque basali minori; subtus spinis duabus anticis validis; brachio brevi, lævi, spinis duabus anteapicalibus oblique positis, obtusis; subtus spinis biseriatis acutis. Pedibus tertiis articulo tertio unguiculato; pedibus quintis capitulo basali brevi. Pedibus abdominalibus longis, subcontortis, longe bifidis, apice acutis, incurvis; parte externa longiori, basi crassiori; parte interna apice compresso-dilatata, acuta vel obtusiori.

Forma II. Pedibus abdominalibus basi articulatis, apicibus paululum divisis, crassioribus, cylindricis, minus incurvis.

Femina differt chelis minoribus; ventre inter pedes quartos lævi, annulo magno, fere cordiformi, fissura transversa, lata, profunda, margine tumido, antice fisso.

Variat interdum angulis rostri ad acuminis basin longioribus brevispinosis; rostri interdum angustiori, acumine longiori; lamina antennarum rostro longiori.

Long. 3.2; long. antenn. 2.4; long. ped. antic. 2.7.

Patria: Lake Superior; Lake Winnipeg; Saskatchavan and Red River, British America, and Toronto, Canada; Quincy, Illinois; Davenport and Burlington, Iowa; Miami River, Dayton, Ohio; Osage River, Missouri; Sugar River, Wisconsin (Mus. Salem); Texas.

I have seen the male of both forms from Lake Superior and from Illinois.

Var. A.

I have seen many full-grown male (Forma II.) and female examples from the Osage River, Missouri, and male and female from the Miami River, Dayton, Ohio, in the Philadelphia Museum, which I cannot yet separate specifically. The rostrum is smaller anteriorly, the thorax seems not so much dilated and less punctated, the areola is a little smaller; the fingers are more separated, the exterior more notched at the base interiorly; the carpus is trispinose beneath at the apex, the third spine is between the great middle interior spine and the two ordinary apical spines; the legs composing the third pair are not so much hooked, and those of the abdomen are similar to those of the second form described.

The male (Forma I.) and female from Davenport, Iowa, are in form and specific character doubtless identical with the examples from Lake Superior; but they agree more nearly with the specimens from the Osage River in the form of the rostrum and the greater development of the spines; the third spine on the carpus is more or less visible.

It is likewise impossible to separate the males and females from Texas. The rostrum is intermediate, but more similar to the Osage examples; the abdominal legs (Forma I.) are of the typical form; the carpus is trispinose, but in some examples from Lake Superior there is a similar third spine very little developed. One male is larger: Long. corp. 4.1; long. ped. antic. 3.7; long. chelæ, 2.2. In this male the fingers are more elongated.

The examples from Burlington, Iowa, are similar to the Texas examples. The male has a little hook at the third joint of the second pair of legs, but a similar monstrosity is not very uncommon. Accidentally the spines on the rostrum are more or less obliterated.

Cat. No. 1151, Lake Superior, L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 194, Lake Superior, L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 203, Lake Superior, L. Agassiz. Male Form II. Fem. Spec. 6.

Cat. No. 1828, Lake Winnipeg, British America, Mr. S. H. Scudder. Male. Fem. Spec. 12.*

Cat. No. 1829, Red River, British America, Mr. S. H. Scudder. Male. Fem. Spec. 12.*

Cat. No. 1830, Saskatchavan River, British America, Mr. S. H. Scudder. Male. Fem. Spec. 4.

Cat. No. 196, Quincy, Ill., Dr. Watson. Male. Fem. Spec. 12.*

Var. A.

Cat. No. 1831, Osage River, Dr. Stolley. Male Form II. Fem. Spec. 12.*

Cat. No. 1832, Osage River, Dr. Stolley. Male Form II. Fem. Spec. 12.*

Cat. No. 192, Osage River, Dr. Stolley. Male Form I. Spec. 1.

Cat. No. 171, Burlington, Iowa. Male Form I. Fem. Spec. 3.

Cat. No. 200, Texas, Dr. Stolley. Male Form I. Fem. Spec. 12.*

Cat. No. 207, Texas, Dr. Stolley. Male Form I. Fem. Spec. 4.

Cat. No. 1833, Davenport, Iowa. Male Form I. Fem. Spec. 3.

Dry Spec., Lake George, L. Agassiz. Male. Spec. 1.

17. Cambarus placidus *Hagen.*

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 76 in front; fig. 77 outside.
not articulated second form, fig. 78 in front; fig. 79 outside.
Antennal lamina, fig. 158, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

This species is intermediate between *C. virilis* and *C. juvenilis*. It lives in the same localities, — Texas, Tennessee, and Quincy, Illinois. In its general form, more cylindrical thorax, smaller and more deeply sulcated rostrum, with the margins more thickened, it resembles *C. juvenilis;* the abdominal legs of the male (Forma I. and II.) are very similar to those of *C. virilis*, though in one male the posterior hook is slightly evident; nevertheless, the forehands are very dissimilar, more slender, much longer, not so much punctated, especially on the fingers, which are flattened; the inner margin of the hands is very little tuberculated; the fingers are more separated at the base, while the external one is not barbated; a few females from Tennessee have little hairs, and are scarcely tuberculated at the inner margin, though sometimes they are much elongated; the carpus is bispinose beneath, the spines often being very obtuse, especially the interior ones; the biseriated

spines beneath the brachium, except the two apical ones, are nearly or quite obliterated, as in *C. juvenilis*. The external maxillary legs are not barbated beneath.

The largest male: Long. corp. 3.5; long. ped. antic. 2.5.

Patria: Lebanon, Tennessee; Quincy, Illinois; Texas.

I have seen more than twenty examples, male (Forma I. and II.) and female. In the males, Forma II., the abdominal legs are not articulated at the base.

Cat. No. 289, Lebanon, Tenn., Mr. J. M. Safford. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 296, Quincy, Ill., Dr. Watson. Male Form I. Spec. 1.

Cat. No. 170, Texas, G. Stolley. Male Form I. and II. Fem. Spec. 12.*

18. Cambarus juvenilis *Hagen.*

Figures on Pl. I. and III.

First abdominal legs of the male:

first form, fig. 29 in front; fig. 30 (Tab. II.) viewed more outwardly; fig. 31 outside.

second form, fig. 32 in front; fig. 33 outside.

Antennal lamina, fig. 157, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro angusto, longiori, sulcato, marginibus basi divergentibus, crassioribus, costato-lineatis; acumine triangulari, angusto, acuto, sinuato, spina utrinque brevi fusco-cornea, subrejecta; cretis subparallelis, vix elevatis, sulcatis, spina antica brevi, fusco-cornea. Antennis corpore paulo longioribus, articulo basali dente externo brevi, articulo secundo dente subnullo; articulo antennarum internarum basali dente infero acuto, magis apicali; lamina parva, rostro fere longiori, angusto, margine externo late inflato, apice longius spinoso. Epistomate lato, antice obtuso-angustiori, lateribus sinuatis, angulis basalibus paulo prominentibus. Pedibus maxillaribus externis intus summaque basi subtus villosis. Thorace fere cylindrico, subdepresso, punctato, punctis ad rostri basin profundis crebrioribus, lateribus leviter granulosis; linea modice profunda, vix sinuata, utrinque fissa, spina parva acuta; spina antica infera nulla; areola angusta, plana postice paulo latiori. Postabdomine thoracis latitudine, fere lævi, segmentis penultimis angulo externo obtuso; lamina media parte apicali breviori, rotundata, parte basali apice angustiori, sinuata, utrinque bispina. Pedibus anticis latis, brevibus; chela lata, depressa, ubique grosso-punctata, margine interno brevi, incurvo, tuberculis squamosis serrato; digitis longioribus, rectis, costatis, ad marginem internum lineato-punctatis, externo subtus basi barbato; carpo lato, extus oblique truncato, sublævi, spina interna media obtusa, subtus antice spinis duabus obtusis; brachio brevi, lævi spinis duobus obtusis anteapicalibus, oblique positis, subtus fere nudo, spinis duabus anticis. Pedibus tertiis articulo tertio unguiculato; pedibus quintis

capitulo basali brevi. Pedibus abdominalibus longis, subcontortis, longe bifidis, dente medio supero, partibus apicalibus gracilibus, spiniformibus, interna breviori, ante apicem sublatiori.

Forma II. Differt pedibus abdominalibus brevioribus, basi articulatis, apice modo bifidis, partibus apicalibus inflatis, cylindricis, dente medio supero nullo.

Vidi mares adultos similes, sed pedibus abdominalibus basi non articulatis.

Femina differt abdomine latiori, chelis angustioribus, minus punctatis, sublævibus; venter inter pedes quartos nudo, fere plano; annulo magno, transverso, fissura transversa lata, profunda, antice bituberculata.

Long. corp. 2.5; antenn. 2.6; ped. chel. 1.8.

Patria: Little Hickman, Kentucky River; Osage River.

Vidi mares utriusque formæ, ac feminas, permultos.

This species is very similar to *C. viridis* Hag., but smaller, the thorax nearly cylindrical, more flattened above; the rostrum is smaller, deeply sulcated, with the margins thickened and laterally not so sharply rectangular, but more oblique; the three apical teeth are more developed; the antennal lamina is smaller, the hands throughout are punctated and more flattened, the spines of the carpus and brachium obtuse; the ordinarily biseriated spines beneath are not at all developed, except the two anterior.

Cat. No. 213, Little Hickman, Kentucky River, Mr. A. Hyatt. Male Form I. Fem. Spec. 12.*

Cat. No. 1834, Little Hickman, Kentucky River, Mr. A. Hyatt. Male Form II., first pair of abdominal legs articulated or not articulated. Spec. 12.*

Cat. No. 271, Osage River, G. Stolley. Male. Spec. 1.

19. Cambarus propinquus *Girard.*

Cambarus propinquus Girard, Proceed. Acad. Philad., T. VI. p. 88.

Figures on Pl. I. and III.

Antennal lamina, fig. 158, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

First abdominal legs of the male:

first form, fig. 34 in front; fig. 35 variety; fig. 36 outside.

second form, fig. 37 in front; fig. 38 outside.

Mas. Rostro angustiori, elongato, subexcavato, marginibus parallelis, punctato-lineatis, apice utrinque sinuatis, spinis lateralibus perparvis fusco-corneis; acumine triangulari, acuto, latitudine rostri longiori, supra leviter carinato; cretis basalibus brevibus, margine distantibus, parallelis, vix elevatis, sulcatis, antice truncatis. Antennis corpore brevioribus, dentibus articulorum basalium brevibus acutis; antennis internis dente anteapicali infero interno acuto; lamina rostri longitudine,

apicem versus latiori, margine externo sinuato, modice inflato, apice spina longiori. Epistomate antice angustiori, truncato, dimidio latiori, lateribus excisis. Pedibus maxillaribus externis intus parum villosis, subtus nudis. Thorace subovoideo, parum-punctato, lateribus subtilissime granulosis; linea profunda, subsinuata, lateribus divisa, spina laterali acuta; areola plana, paulo latiori, antice posticeque æquo dilatata. Postabdomine thorace subangustiori, fere lævi, segmentis penultimis angulo externo mutico; lamina media parte apicali breviori, subangustiori, rotundata; parte basali quadrangulari, antice utrinque bispinosa. Pedibus anticis brevibus, chela modice lata, subdepressa, punctata, subtus lævi, margine interno brevi, recto, paululum serrato; digitis fere duplo longioribus, rectis, margine interno costato-lineatis, basi intus subdentatis. Carpo lato, oblique truncato, sublævi, spina media interna, subtus spina solum externa antica valida. Brachio brevi, lævi, spinis duabus anteapicalibus oblique positis, spinis inferis biseriatis, duabus anticis exceptis submullis. Pedibus tertiis articulo tertio unguiculato. Pedibus quintis capitulo basali cylindrico. Pedibus abdominalibus brevioribus, subcontortis, apice modo bifidis, partibus cylindricis, crassioribus, æqualibus, parte interna, apice subacuta paulo introrsus curvata, parte externa fusco-cornea, tenuiori, acuta.

Forma II. differt chela angustiori, crassiori, læviori; pedibus abdominalibus, basi articulatis (interdum non articulatis) partibus apicalibus æqualibus, parte externa non fusco cornea.

Femina differt chelis minoribus; ventre inter pedes quartos lævi, annulo obovato, subdepresso, fissura longitudinali dentata, apertura transversali nulla.

Long. corp. 2.6; long. ped. ant. 2.3.

Ordinarily, long. corp. 1.5 at 2.

Patria: Lake Oneida; Lake Superior; Niagara; Ogle County, Illinois; Delphi, Indiana; Rochester, N. Y.

I have seen many examples. In one abnormal male the third pair of legs are not hooked; some males have the third joint of the second pair of legs hooked.

A male type (Forma I.) found by Professor Baird on Grass River, St. Lawrence County, N. Y., and communicated by Professor Stimpson, is identical with the specimens from Lake Superior. Mr. Girard has seen specimens of this species from Lake Ontario, Garrison Creek, Sackett's Harbor, Four-Mile Creek, Oswego.

In one abnormal male the first pair of the abdominal legs are not developed, but they have the same shape as those of the females.

One male, Delphi, Indiana, is larger, long. corp. 3.2; ped. ant. 3.1, but very similar. The hands are more developed, as is commonly the case in old males; the abdominal legs are similar in form, but the posterior margin is a little hooked in the middle, and more emarginated

before the base. The rostrum is carinated as in the type. The identity is rendered much more probable, since I have seen from the same locality male and female types, both full grown and young, and the two forms of the male. In one male, nearly full grown, the rostrum is scarcely carinated at all.

Two males, Forma I., from Rochester, N. Y., were mixed with *C. obscurus*.

The very young and small specimens much resemble those of *C. affinis*. The rostrum is more acute, the thorns at the base of the acumen long and acute, the exterior margin of the antennal lamina sinuated, but the acumen is always a little carinated, and the hands are broader and shorter.

C. propinquus Gir. differs from *C. virilis* in having its rostrum carinated and narrower, with the acumen longer than broad; the cephalothoracic carinæ more distant from the margin; the lamina of the antennæ narrower, more acute; the maxillary legs without hairs externally; the carpus below with only one anterior spine, the brachium externally smooth; the inner margin of the chela straight; the areola broader, but not so much enlarged behind; the lamina media of the postabdomen more rounded. The angle of the cephalothoracic margin behind the eyes is almost obliterated.

Cat. No. 202, Lake Superior, L. Agassiz. Male Form II. Spec. 12.*

Cat. No. 1835, Lake Superior, L. Agassiz. Male Form I. Spec. 12.*

Cat. No. 206, Lake Superior, L. Agassiz. Fem. Spec. 12.*

Cat. No. 1836, Ugle County, Ill. Male. Fem. Spec. 6.

Cat. No. 1837, locality unknown. Male Form II., first pair of abdominal legs not articulated. Spec. 3.

Cat. No. 268, Delphi, Indiana, Mr. F. C. Hill. Male. Fem. Spec. 12.*

Cat. No. 205, Niagara, L. Agassiz. Male. Fem. Spec. 12.*

Cat. No. 247, Niagara, L. Agassiz. Fem. Spec. 1.

Cat. No. 185, Niagara, L. Agassiz. Male. Fem. Spec. 12.*

Cat. No. 1838, Rochester, N. Y., Professor C. Dewey. Male. Spec. 2.

Cat. No. 1839, Lake Oneida. Male. Spec. 3.

Dry Spec., Niagara, L. Agassiz. Male. Fem. Spec. 2.

20. Cambarus obscurus *Hagen.*

Figures on Pl. I. and III.
First abdominal legs of the male.
first form, fig. 72 in front; fig. 73 outside.
second form, fig. 74 in front; fig. 75 outside.
Antennal lamina, fig. 154, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Male. This species is very similar to *C. propinquus*, and I have seen the males from the same locality mixed in the same bottle. But hav-

ing compared many full-grown individuals, I find the following differences: —

Rostro non carinato, antice plano, vix angustiori; cretis basalibus brevioribus; lamina apice acutiori, margine externo non sinuato; epistomate antice magis truncato; chela latiori, planiori, margine interno incurvo, distincte biseriatim tuberculato, linea tuberculosa alia paululum distante versus basin mediam digiti mobilis; digitis brevioribus, latioribus, externo incurvo, basi magis distantibus; carpo subtus spinis anticis distinctis; pedibus abdominalibus margine postico medio dentato; parte interna lata recta, fere carinata, apice obtusa; postabdomine laminæ mediæ parte apicali breviori.

Forma II., pedibus abdominalibus basi articulatis, margine postico non dentato; partibus magis inflatis, externa cylindrica obtusa.

Femina differt annulo apertura transversali antice bituberculata; tuberculo ventrali inter pedes secundos.

Long. corp. 3.5; antenn. 2.5; ped. antic. 2.5.

Patria: Genesee River, Rochester, N. Y.

Vidi 30 specimina.

This species is perhaps *A. fossor* Rafinesque, Amer. Monthl. Magaz., T. II. p. 42. The description is very short, and contains nothing contradictory, while the granular "gaping" toothed hand seems to designate this species rather than *C. propinquus*.

"*A. fossor*. Antennæ as long as the body, rostrum short, one-toothed on each side, a thorn behind the eyes; three pairs of spiniferous feet, hands of the first pair very large, granular-gaping-toothed, with a furrowed and bispinous wrist. Obs. Vulgar name, burrowing lobster, — communicated to me by Dr. Samuel L. Mitchell, — native of Virginia, Pennsylvania, and New York; size from four to six inches; it burrows in meadows and milldams, which it perforates and damages."

The dimensions are greater than in the specimens before me. Among the seven species known from New York, this species and *C. propinquus* are the only ones answering to Mr. Rafinesque's description. From Pennsylvania I know only *C. affinis* and *Bartonii*, from Virginia only *C. Bartonii* and *C. obesus*.

I do not know whether *C. obscurus* burrows in dams; should this peculiarity be made out, the name proposed by Mr. Rafinesque must be restored.

Cat. No. 181, Genesee River, Rochester, N. Y., Mr. H. A. Ward. Male. Fem. Spec. 12.*

Cat. No. 1840, Genesee River, Rochester, N. Y., Mr. H. A. Ward. Male Form I. Fem. Spec. 12.*

Cat. No. 1841, Genesee River, Rochester, N. Y., Mr. H. A. Ward. Male Form II. Spec. 3.

21. Cambarus rusticus *Girard.*

Cambarus rusticus Girard, Proc. Acad. Philad., T. 6, p. 88.

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 80 in front; fig. 81 outside.
second form, fig. 82 in front; fig. 83 outside.
Antennal lamina, fig. 161, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

I have heretofore considered the males and females from Cincinnati, Ohio, which belong to *C. rusticus* Gir., as a variety of *C. propinquus*; the rostrum, however, is never carinated. The specimens are very closely allied to *C. placidus*; still, the apex of the abdominal legs is nearly straight, while in *C. placidus* it is slightly incurved.

They are very similar to *C. propinquus*, though the rostrum is narrower and concave on the sides, the acumen shorter, the inner margin of the hand is incurved, the interior spine of the carpus less developed, while there are two apical spines beneath, the inner one being the smaller; the brachium is more biseriated spinose beneath; the fingers are more separated at the base; the rostrum has the acumen excavated, not carinated; the external part of the abdominal legs is a little longer; the posterior margin hooked as in *C. obscurus*; in the female there is a triangular lumen in the annulus; the external parts of the two antepenultimate segments of the postabdomen are nearly rectangular.

Long. corp. 3; long. antenn. 2.6; long. ped. antic. 2.5.

Patria: Cincinnati, Ohio. I have compared a male type, Forma II., communicated by Professor W. Stimpson. I have seen nine examples, male, Formæ I. and II., and female. The abdominal legs in the Forma II. are not articulated at the base. One male from Lake Superior seems not to differ.

While this species is very near to *C. placidus*, the apical parts of the abdominal legs are shorter and more nearly straight. Nevertheless, the identity is not impossible. *C. obscurus* is very similar, but instantly separated by the truncated epistoma.

Cat. No. 285, Cincinnati, Ohio. Male. Fem. Spec. 12.*

Cat. No. 187, Lake Superior, L. Agassiz. Male Form I. Spec. 1.

22. Cambarus immunis *Hagen.*

Figures on Pl. I., III., and VIII.
First abdominal legs of the male.
first form, fig. 105 in front; fig. 106 outside.
Antennal lamina, fig. 160, *a*; epistoma, *b*; variety, *d*; spine of the second joint of the exterior antennæ, *c*.
Pl. VIII. Hand.

Mas. Rostro lato, dimidio longiori, supra excavato, lævi, basi foveola,

antice vallata, dense punctata, marginibus ad acuminis apicem elevatis, vix punctato-lineatis, antice convergentibus, apice leviter sinuatis, acumine brevi, triangulari, acuto, dentibus lateralibus nullis; cretis basalibus subdivergentibus, vix elevatis, extus sulcatis, antice muticis. Antennis gracilibus, thorace paulo longioribus, articulo basali dente externo parvo acuto, articulo secundo dente perparvo; antennis internis dente medio articuli basalis infero; lamina rostro vix longiori, lata, apice subtruncata, margine externo inflato, brevi-spinoso. Epistomate lato, apice exciso (vel truncato, spina media perparva), lateribus obliquis, angulis rotundatis. Pedibus maxillaribus externis intus et subtus villosis. Thorace subcylindrico, compresso, supra fortiter punctato, lateribus lævioribus; linea profunda, sinuata, lateribus divisa, spina utrinque parva, aliaque antica ad antennas infera minori; areola plana, punctata, angusta, postice valde dilatata. Postabdomine thoracis latitudine, lævi, segmentis antepenultimis angulo externo rotundato; lamina intermedia parte apicali vix breviori, rotundata, medio subexcisa; parte basali utrinque bispina. Pedibus anticis modicis, brevioribus; chela modice lata, depressa, leviter punctata, subtus lævi, extus marginata; margine interno brevi, subrecto, tuberculato-serrato; digitis longioribus, rectis, apice corneis, incurvis, supra costatis et punctato-lineatis; digiti mobilis margine externo serrato, interno basi exciso, tuberculato; digito externo tuberculo medio et basali minoribus, basi subtus valde barbata. Carpo lato, extus valde oblique-truncato, spina interna media majori, aliisque brevioribus; subtus antice et intus multispinoso, duabus anticis majoribus. Brachio brevi, lævi, margine supero parce tuberculoso, spinis duabus parvis anteapicalibus minoribus; subtus spinis obtusis biseriatis, anticis nonnullis majoribus. Pedibus secundis intus ante apicem valde barbatis. Pedibus tertiis articulo tertio unguiculato; pedibus quintis capitulo basali annulari. Pedibus abdominalibus modicis, contortis, longe bifidis, margine postico medio subito latiori, parte interna cylindrica, apice acuta, depressa, incurva, subdilatata; parte externa paulo longiori, acuta, incurva.

Femina differt chelis minoribus, pedibus secundis minus barbatis; ventre inter pedes quartos lævi, annulo obovali, fissura denticulata, apertura magna transversa; ventre inter pedes tertios tuberculo apicali planiori.

Long. corp. 2.6; long. antenn. 1.5; ped. antic. 2.

Vidi marem (ex Alabama) paulo majorem, chelis medio magis dilatatis, digito externo intus curvo.

Patria: Lawn Ridge and Belleville, Illinois; Huntsville, Alabama.

I have not seen the second form of the male.

A female from Beaufort, N. C., is a little smaller, the antennal lamina not so broad at the tip, the areola a little narrower, the hands are very small, the moving finger has its inner margin straight, without basal

excision; the example is otherwise similar to *C. immunis;* nevertheless, it possibly belongs to a different species.

C. immunis is a very interesting species; by its conical, short, and toothless rostrum it is allied to the group of *C. Bartonii*, by the abdominal legs of the male to the group of *C. affinis*. I have not seen young specimens; they, perhaps, possess lateral spines.

Cat. No. 188, Lawn Ridge, Ill., Mr. C. Ordway. Male. Fem. Spec. 5.
Cat. No. 1841, Belleville, Ill. Male. Spec. 1.
Cat. No. 301, Huntsville, Ala. Male. Spec. 1.
Cat. No. 1842, Beaufort, N. C., Mr. Bickmore. Fem. Spec. 1.

23. Cambarus extraneus *Hagen.*

Figures on Pl. I. and III.
First abdominal legs of the male:
second form, fig. 88 in front; fig. 89 outside.
Antennal lamina, fig. 156, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro lato, duplo vel triplo-longiori, lævi, excavato, marginibus punctato-lineatis, subparallelis vel subconvergentibus, utrinque ad apicem fortiter sinuatis; acumine longo, acuto, utrinque dente brevi, acuto; cretis parum elevatis, parallelis, sulcatis, spina acuta antica. Antennis validis (basis modo exstat), articulis duobus basalibus dente externo acuto, antennis internis articulo basali dente infero acuto; lamina rostri longitudine, modice lata, margine externo late inflato, apice spina acuta longiori. Epistomate brevi, lato, antice obtuso, rotundato, angulis lateralibus acutioribus; pedibus maxillaribus externis intus barbatis. Thorace leviter ovato, densius punctato-ciliato, lateribus granulosis, scabris; linea profunda, subfissa, utrinque spina valida acuta; spina antica infera ad antennarum basin; areola lata, plana, punctata, antice posticeque paulo dilatata, cephalothorace margine antico ad basin antennarum loco anguli dente parvo acuto. Postabdomine thoracis latitudine, paulo longiori, parce punctato, segmentis antepenultimis angulo laterali subrecto; lamina intermedia utrinque bispinosa, parte apicali breviori, rotundata. Pedibus anticis modicis; chela magna, lata, depressa, densius punctato-ciliata; margine interno longo, subrecto, biseriatim tuberculato-dentato; digitis validis, planis longioribus, costato-lineatis, intus dentatis, basi subtus barbatis. Carpo lato, oblique truncato, parumpunctato, spina interna media majori, aliaque basali brevi; subtus spinis duabus anticis validis. Brachio longiori, lævi, spinis duabus anteapicalibus validis, oblique positis, subtus spinis acutis biseriatis, spina ad articulationem utrinque valida. Pedibus tertiis articulo tertio unguiculato; pedibus quartis capitulo basali ovato, parvo. (Forma I. mihi invisa.)

Forma II. Pedibus abdominalibus basi articulatis, validis, brevibus, contortis; parte interna cylindrica, brevi, apice acutiori recurva; parte

externa valida, antice impressa, apice compressa, dente valido recurvo, obtuso, intus duplici.

Vidi marem majorem pedibus abdominalibus non articulatis.

Femina differt abdomine latiori; ventre inter pedes quartos lævi, annulo transverso, lumine posteriori plano, sulco antico longitudinali, utrinque tuberculo rotundato.

Long. corp. 3.3; ped. antic. 2.

Habitat: Tennessee River, Georgia. The label is no doubt in part erroneous, as no portion of the Tennessee River flows through Georgia.

I have seen six specimens (three males, three females), of which the largest was a female. The males belong to Forma II., though the largest have the abdominal legs unarticulated. Apparently the males, Forma I., have larger hands and a more finished sculpture. In all the specimens the whole animal is punctuous-ciliated. The thorax is a little shorter than the abdomen.

A. affinis Say differs in having a double spine on each side of the thorax, in the very unlike forms of the abdominal legs, in the absence of the thoracic marginal spine behind the eyes, and in its larger areola. I cannot discover this species in Mr. LeConte's monograph.

It is possible that the larger female belongs to a different species; the five others are identical, the rostrum being visibly attenuated before, the acumen shorter, and the area broader. This female seems very near *C. affinis* Say. The species itself is very remarkable in having the abdominal legs formed exactly as in the group of *C. Bartoni.*

Cat. No. 175, Tennessee River, (near the borders of?) Georgia, Colonel Jones and Dr. Daniell. Male Form I. and II. Fem. Spec. 6.

III. GROUP. (Type C. Bartonii.)

The third legs of the males hooked; rostrum short, toothless; first pair of abdominal legs with the tip of the exterior part recurved, the tip of the interior part short.

This group, perhaps, unites two groups of co-ordinate value. It is, of course, possible that an examination of a greater number of specimens of *C. Carolinus* and other allied species would allow us to place them in another different group.

1. *C. Bartonii* and the allied species (except *C. Carolinus* and *C. advena*) form a very natural group. Hooks only occur in the males on the third pair of legs. The rostrum is short, broad, obtuse at the tip and toothless, even in the young animals. The antennæ are shorter than the body; their lamina is short and dilated near the tip; the spine beneath the first joint of the inner antennæ is more apical; the flagellum is short, the inner branch a little more slender, shorter, and the joints are sometimes more calcareous and fragile, similar to those of the true

Astacus. The foreborder of the cephalothorax is strongly angulated. The body, especially the postabdomen and the hands, is broader. The first pair of abdominal legs of the male has a peculiar and striking development. The tip of the exterior part forms a larger and more strongly recurved tooth; the tip of the interior part is broken, short, and conical. The second pair of legs and the third are ciliated with hairs. Burrowing habits are observed in *C. Diogenes* (united by me with *C. Bartonii*).

2. The other group, *C. Carolinus* and *C. advena*, differs in having the front border of the cephalothorax not angulated, the very narrow postabdomen, and principally in the form of the first abdominal legs, similar to those described in *C. acutus*.

Synopsis of the Species.

1st Section.

Front border of the cephalothorax angulated; first abdominal legs strongly hooked.

A. Areola linear: *C. obesus*, *C. Nebrascensis*.

B. Areola broad: *C. Bartonii* (with *C. pusillus*, *C. montanus*, *C. longulus*, *C. Diogenes*), *C. robustus*, *C. latimanus*.

Incertæ sedis: *C. Mexicanus*, *C. Cubensis*.

2d Section.

Front border of the cephalothorax straight; first abdominal legs not hooked: *C. advena*, *C. Carolinus*.

The determination of the species in this group is not so certain as in the foregoing groups. In some species the entire lack of typical specimens, or the insufficiency of materials, has perhaps misled me and occasioned errors.

This is especially the case in the species united by me with *C. Bartonii*, viz. in *C. pusillus*, *C. montanus*, *C. longulus*, and *C. Diogenes*. More ample material will either confirm my views or correct my errors.

24. Cambarus Bartonii *Fabricius*.

Astacus Bartonii Fabr., Supplem. Ent., p. 407, n. 3. — Bosc., Hist. Nat. Crust., T. II. p. 40. — Latr., Hist. Nat. Crust., T. VI. p. 240. — Say, Journ. Acad. N. Sc. Philad., T. I. p. 167, 2. — Harlan, Med. and Phys. Research., p. 230, fig. 3. — Erichson, Archiv. T. XII. p. 97, n. 17. — DeKay, N. Y. Zoölogy, VI. 22, Pl. 8, fig. 25.

Figures on Pl. I., II., and III.

First abdominal legs of the male:

first form, fig. 47 in front; fig. 48 outside.

second form, fig. 49 in front; fig. 50 outside.

Inner sexual parts of the male:

first form, fig. 135; side, fig. 136.

second form, fig. 137; side, fig. 138.

Inner sexual parts of the female, fig. 139.

Antennal lamina, fig. 166, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro brevi, lato, fere quadrangulari, ante apicem utrinque

subito sinuato, acumine latitudine rostri breviori, acuto; supra fere plano, marginibus antice ad acuminis apicem elevatis; basi foveola latiori, punctata; cretis basalibus parvis, vix rostro separatis, parallelis, extus linea punctata impressis, antice subacutis. Antennis corpore brevioribus; articulo basali dente parvo, acuto; antennis internis articulo basali spina infera antica acuta. Lamina brevi, angusta, rostro sublongiori, apice angustiori, margine externo latius inflato, apice spina longiori, acuta. Epistomate semicirculari, spina media antica; pedibus maxillaribus externis intus barbatis. Thorace subcylindrico, paulo depresso, postice subangustato, punctato, lateribus granulato; cephalothorace medio lævi; linea profunda, sinuata, spina parva infera antica ad antennarum basin; areola modica, plana, punctata, postice latiori. Postabdomine vix angustiori, punctato, segmentis antepenultimis angulis rotundatis; lamina media bispina; parte apicali æquali elliptica. Pedibus anticis brevibus, modicis; chela lata, subinflata, punctata; margine brevi dentato, interdum biseriatim tuberculato, recto, subtus sulcato; digitis validis basi non claudentibus, costatis, fortiter punctato-lineatis, dimidio longioribus, rectis, paululum subtus curvatis, intus dentatis. Brachio brevi, lævi, ante apicem supra obsolete-tuberculoso, subtus spinis biseriatis acutis. Carpo lato, oblique truncato, rarius punctato, spina media interna majori, aliaque basali minori; subtus spinis duabus anticis obtusis. Pedibus secundis densius ciliatis; pedibus tertiis articulo tertio unguiculato; pedibus quartis capitulo basali ovali. Pedibus abdominalibus brevibus, validis, contortis, subtus medio depressis, parte interna cylindrica, apice acuta, incurva; parte externa longiori, latiori, intus plana, apice dente separato, compresso, longo, incurvo, margine externo fusco-corneo, striato.

Forma II. differt chela angustiori, digitis longioribus, sæpe basi claudentibus. Pedibus abdominalibus brevibus, validis, contortis, basi articulatis, parte interna brevi, cylindrica, apice extus curvata ac subito acuminata; parte externa latiori, intus plana, apice dente magno, obtuso, recurvo, compresso, intus duplici. Variat pedibus basi non articulatis, chela perparva, digitis fere cylindricis; carpo interdum spina interna media singula.

Femina differt chelis minoribus; ventre inter pedes quartos lævi; annulo cordiformi, lumine transverso postico, sulcoque angusto antico longitudinali; abdomine latiori, summa basi angustato.

Long. corp. 2.8 – 3.6; antenn. 1.5 – 3.8; ped. antic. 2 – 2.5

Patria: Lake Superior; Lake Champlain, Burlington, Vermont (Salem Museum); Elizabethtown, Essex County, and Berkshire, Tioga County, Fishkill and Newburg (Rafinesque), N. Y.; Schooley's Mount, New Jersey; Schuylkill River, Philadelphia, and Berwick, Pennsylvania; Cincinnati, Scioto River, Columbia, Ohio; Hickman's Landing, Kentucky River; Georgetown, D. C.; Osage River, Missouri; Georgia; Greenbrier River, Virginia.

I have seen more than four hundred specimens, both very young and very old. The shape of the rostrum is variable, sometimes broader and quadrangular; the sculpture is different, the oldest individuals are most strongly tuberculated; the antennæ are shorter than the abdomen, though in one male (the largest seen by me) they are a little longer than the abdomen. The hands are variable in form, often very broad, and the fingers much separated at the base; the abdominal legs in the second form are often not articulated.

It is possible that *A. Bartonii* Fabr. belongs to this species; the description contains no contradictory characters. The description by Bose is too short, and his figure too imperfect to afford any help. The species of Say, Harlan, Erichson, are apparently identical. DeKay's (N. Y. Fauna, T. 6, p. 20, T. 8, fig. 25) description is very brief and the figure poor, still I think the species the same. *A. affinis* M. Edwards seems to be the same (Crust. II. p. 332, n. 3). *A. Bartonii* M. Edwards is *C. affinis*. I do not know whether M. Edwards has seen the type of Bose.

Girard gives (Proc. Acad. Philad., No. 8, T. 6, p. 88) no description of his *Bartonii*, but he quotes the works above-mentioned. Girard cites as identical *A. ciliaris* Rafinesque (Amer. Month. Mag. II. No. 3, p. 42), and this is possibly true of very large specimens.

Girard describes (l. c. p. 90, n. 13) *A. pusillus* Rafin. The description by Rafinesque (l. c. No. 4, p. 42) is too short, "the rostrum oval acute," and "wrist smooth," being the only important characters given. The comparative description by Girard is not sufficient, though the Cambridge Museum possesses one female from Lake Champlain by Professor Baird, possibly the *A. pusillus* Rafinesque.

I suppose that *C. pusillus* does not differ from *A. Bartonii*, because the examples from the North, Lake Superior, and other localities are always very small. The external lamina of the postabdomen has the inner third of the apical margin of the basal part not denticulated; in *C. obesus* it is entirely denticulated. Cilia evidently occur on the second pair of legs, and justify the name given by Rafinesque. The basal inner angle of the hand is nearly rectangular.

I have seen a female from the Mammoth Cave, Kentucky, with the eyes well developed, and a female from Georgia.

In the largest male from Ohio the antennæ are longer than the body, — a character given for *C. montanus* Girard, — but the areola is not broader.

I have compared a female type from Berwick, Pennsylvania, labelled *C. Bartonii* Er., and communicated by Professor Stimpson. The specimen is from the locality mentioned by Mr. Girard and identical with the specimens described by me from Schuylkill River.

I have also compared *Cambarus montanus* Girard, l. c. p. 88, male type from Greenbrier River, Virginia, communicated by Professor Stimp-

son. It is a young male of the second form, with the abdominal legs articulated. The animal is identical with *C. Bartonii*, and the shape of the epistoma forbids us to regard it as a young *C. latimanus*. The external lamina of the postabdomen has the inner third of its margin not denticulated. A dry male specimen from Virginia, *C. montanus*, Acad. Philad., is identical with the foregoing, the abdominal legs exactly resemble those of *C. Bartonii*. In the Cambridge Museum there is a jar with alcoholic specimens labelled, Isle of Pico, Azores, presented by Mrs. Dabney. It contains one *Alpheus* and three *C. Bartonii*. It seems very doubtful at present that these *Cambari* are from the Azores. The types in the Cambridge Museum of *A. Bartonii* Gibbes, mentioned in his Fauna of South Carolina, belong to *C. latimanus*. The types of *C. Bartonii* in the Mus. Acad. Philadelphia, from Pennsylvania and Pittsburg, also determined by Mr. L. R. Gibbes, are *C. affinis* Say.

A female type of *C. longulus* Gir., Proc. Acad. Philad., T. 6, p. 90, communicated by Professor Stimpson, is from the Middle States; it differs from *C. Bartonii* in having its hands smooth, very large, and apparently deformed. The fingers are small and unusually far separated at the base. In the space between them is a large bunch of hairs. I have not found such a bunch of hairs in any specimen of *C. Bartonii*; perhaps there was more room for the growth of these hairs in this deformed specimen. But I should remark that specimens of *C. Bartonii*, with the fingers about as widely separated, are destitute of any such tufts. I have sometimes found hairs in this place, but never so many in *C. latimanus*. Nevertheless, the other characters show that it must be *C. Bartonii* or a new species. I think it is *C. Bartonii*.

C. Bartonii is the most variable species; as yet I cannot find stable and constant characters for dividing them into three or four species, as Mr. Girard has done. The rostrum is often nearly quadrangular, with a little tooth in the middle of its front border, and varies in being more elongated, more attenuated before, with the angles more or less rounded and the apical tooth longer or shorter, broader or narrower. The lamina of the antennæ varies in breadth, principally in front, and in the length of the apical spine. The epistoma is often triangular, acute, often more rounded laterally, sometimes more obtuse at the tip and nearly truncated in front. The dorsal areola varies in specimens from the same locality (Cincinnati from $\frac{2}{6^4}$ to $\frac{8}{6^4}$ inches). The form of the hand is exceedingly variable, the fingers being often broadly separated at their base, frequently nearly contiguous.

The type of *C. montanus* does not differ from the typical form. The length of the antennæ quoted by Girard is variable. One male from Cincinnati, with the most quadrangular rostrum, has the antennæ even longer than the body.

I have seen more than one hundred specimens from Lake Superior,

Lake Champlain, and from the Aquarial Gardens in Boston (locality uncertain, but perhaps from the Northern Lakes), which belong undoubtedly to *C. pusillus*; still the differences given by Mr. Girard are not sufficient for separating *C. pusillus* from *C. Bartonii*.

The type of *C. longulus* is, as I think, merely an accidental variety of *C. Bartonii*. The fingers are cylindrical, very widely separated at the base, and bearded in this place and inside of the external finger, along the basal half. The shape of the finger is unusual and, I think, accidental. Broadly separated fingers are sometimes seen; the Museum possesses a specimen having the fingers on the right hand separated and those on the left hand contiguous; but I have never seen the space between the fingers bearded with hairs. The other differences quoted by Mr. Girard, and taken from the shape of the rostrum and the breadth of the areola, are not important enough to warrant a specific separation.

Mr. Say, Journ. Acad. Philad., T. 1. p. 443, says: "*A. Bartonii* has the hands differently proportioned with respect to the thumb, and more or less muricated. They are extremely common in the pine barren marshes of the Southern States, and particularly in those of Georgia and Florida." I have not seen specimens from there, but they perhaps belong to *A. latimanus*.

Cat. No. 1847, Aquarial Garden, Boston, L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 284, Berkshire, Tioga County, N. Y., L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 278, Schooley's Mount, N. Y., Mr. A. Mayor. Male. Fem., young. Spec. 8.

Cat. No. 290, Elizabethtown, N. Y., Professor Baird. Male Form II. Fem. Spec. 3.

Cat. No. 231, Lake Champlain, Professor Baird. Fem. Spec. 1.

Cat. No. 227, New Jersey, L. Agassiz. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 235, Schuylkill River, Penn., L. Agassiz. Male. Fem. Spec. 12.*

Cat. No. 238, Philadelphia, Penn., Dr. Leidy. Male Form I. and II. Fem. Spec. 12.*

Cat. No. 244, Lake Superior, L. Agassiz. Male Form II. Fem. Spec. 12.*

Cat. No. 243, Cincinnati, Ohio. Male Form II. Fem. Spec. 3.

Cat. No. 267, Cincinnati, Ohio. Male Form II. Fem. Spec. 3.

Cat. No. 288, Cincinnati, Ohio, L. Agassiz. Male. Fem., young. Spec. 12.*

Cat. No. 295, Scioto River, Columbia, Ohio, Mr. J. Sullivan. Male Form II. Fem. Spec. 6.

Cat. No. 286, Mammoth Cave, Kentucky. Fem. Spec. 1.

Cat. No. 240, Hickman's Landing, Kentucky River, Mr. A. Hyatt. Fem. Spec. 1.

Cat. No. 183, Osage River, Mr. Stolley. Male Form II. Fem. Spec. 8.

Cat. No. 237, Georgetown, D. C., Lanman. Male Form II., the first pair of abdominal legs not articulated. Spec. 1.

? Cat. No. 1101, Pico, Azores, Mrs. Dabney. Male. Fem. Spec. 4. (The last locality is apparently erroneous.)

Dry spec., Niagara, L. Agassiz. Male. Spec. 1.

25. Cambarus robustus *Girard.*

Cambarus robustus Girard, Proc. Acad. Philad., T. 6, p. 90.

Antennal lamina, fig. 156, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

C. Bartonii similis, sed differt: rostro excavato, longiori, antice angustiori, acumine triangulari, rostri latitudine longiori; lamina antennarum longiori, antice latiori; articulo antennarum secundo dente externo acuto; epistomate triangulari, lateribus paulo rotundatis; thorace subovato; linea thoracica spina utrinque laterali; chela margine interno serie duplice tuberculorum serrata, digito externo supra ac subtus impresso, excavato; carpo tuberculo parvo inter spina antica et illa anteriori marginis interni.

Long. 3.2; antenn. 2.5; ped. ant. 2.

Habitat: Toronto, Humber River; Genesee River, Rochester, and Lake Regis, N. Y. Two females from Fredericksburg, Virginia (Salem Mus.).

I have seen one typical male, second form, from Toronto, in the Philadelphia Academy, and some specimens from New York, both forms of the male and female, all full grown. The abdominal legs of the male have somewhat more resemblance to those of *C. latimanus*. The rostrum and the hands, the external finger of which shows a very visible impression, separate this species from *C. Bartonii*.

C. obesus differs constantly in the linear areola. *C. latimanus* has no lateral thoracic spine, a more rounded thorax, the carpus beneath strongly tuberculated on the inner side; besides the different and more elongated rostrum, and the rounded not impressed under side of the external finger.

Cat. No. 176, Genesee River, Rochester, N. Y., Mr. H. A. Ward. Male Form. II. Fem. Spec. 12.*

Cat. No. 1176, Western New York, L. Agassiz. Male. Spec. 4.

26. Cambarus obesus *Hagen.*

Figures on Pl. I., III., and IX.
First abdominal legs of the male:
first form, fig. 39 in front; fig. 40 outside.
second form, not articulated, fig. 41 in front; fig. 42 outside.
Antennal lamina, fig. 163, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.
Pl. XI. Male, first form.

Mas. Rostro lato, brevi, latitudine paululum longiori, antice angustiori, acumine brevi, late triangulari, acuto; rostro supra excavato, lævi, marginibus subito elevatis, ad acuminis apicem non interruptis; foveola basali latiori; cretis subdivergentibus, obsoletis, extus punctato-sulcatis, antice muticis postice calloso-inflatis. Antennis validis, thorace vix longioribus, articulis basalibus dente externo subnullo; antennis internis articulo basali dente medio infero parvo; lamina brevi, angusta, intus non dilatata, margine externo latius inflato, spina apicali longiori. Epistomate longitudine vix latiori, elliptico, angulis externis obtusis; pedibus maxillaribus externis intus barbatis. Thorace valido, cephalothorace supra punctis profundis rarioribus, lateribus sparsim granulosis; mesothorace compresso, supra depresso, subtilissime punctato, punctis profundis rarioribus sparsis, lateribus vix granulato; linea profunda, sinuata, antice spina ad antennarum basin infera nulla; areola nulla, linea intermedia profunda; spatio triangulari postico latiori. Postabdomine lato, segmentis anteapicalibus angulis externis rotundatis; lamina media bi-(vel tri-)spinosa, parte apicali æquali elliptica. Pedibus anticis longis, validis; chela magna, latissima, subdepressa, lævi, punctis rarioribus; margine interno brevi, incurvo, forte biseriatim tuberculato; margine externo incurvo, punctato-lineato; digitis plus duplo longioribus, latis, costatis, profunde bilineato-punctatis; interno basi intus exciso, dimidio basali extus et intus tuberculato; externo triangulari, basi forte depresso, acutiori, tuberculis majoribus basalibus internis; supra ad marginem externum dense exsculpto. Carpo lato, oblique truncato, lævi, punctis nonnullis profundis, tuberculis internis rarioribus, subantico majori; subtus lævi, spinis duabus anticis obtusis. Brachio valido; lævi, tuberculis nonnullis anteapicalibus, duabus oblique positis majoribus; subtus spinis obtusis biseriatis. Pedibus tertiis articulo tertio unguiculato; pedibus quartis capitulo basali compresso ovali, quintis subnullo. Pedibus abdominalibus brevibus, validis, contortis; intus latis, planis; parte interna breviori, apice conica, extus curvata; parte externa longiori, apice intus curvata compressa, dente lato, fusco corneo, striato, intus duplici, valde incurvo.

Forma II. Differt chelis minoribus, unguiculis parvis; pedibus abdominalibus non articulatis, parte interna conica, longiori; parte externa apice nec fusco cornea, nec striata, obtusa incurva.

Femina differt antennis brevioribus, chelis minoribus, ventre inter

pedes quartos lævi, annulo transverso inflato, apertura media profunda transversali; postabdomine latiori, basi summa angustiori.

(Maxim.) Long. corp. 4.5; antenn. 2.6; ped. antic. 4.

Habitat: Evanston, Lawn Ridge, and Belleville, Illinois, and the prairies near Chicago (Philad. Acad.); Petersburg, Va.; Monticello, Miss.; Arkansas; New Orleans; Kelley's Island, Ohio; Lake Erie; Lake Michigan; Garrison Creek; Sackett's Harbor; Lake Ontario.

Vidi 16 specimina. The Salem Museum contains a full-grown male and a very young male of the second form, the abdominal legs not being articulated.

C. obesus is very similar to *C. latimanus*, but the "areola nulla" always separates them instantly. The thorax is more ovoid than in *C. latimanus*. The epistoma is not pointed anteriorly, the second joint of the external antennæ has no spine; the carinæ are posteriorly calloso-inflatæ.

One female (Garrison Creek, Philad. Acad.) was labelled *C. propinquus?* but the type of *C. propinquus*, communicated by Professor Stimpson, is a different species.

I have not seen the *C. diogenes* Girard. Although he treated of it at some length, he left it without an accurate description. The dorsal lines of the carapace are almost contiguous, so that the areola is almost wanting. I am in doubt whether it can be referred to *C. obesus*. The only specimen, from Georgetown, D. C., in the Museum is *C. Bartonii*. Perhaps *C. Diogenes* is also *C. Bartonii*.

A specimen from the District of Columbia, labelled *C. Diogenes*, in the Museum of the Philad. Acad., does not agree at all with the description of Mr. Girard, and is *C. propinquus*.

A single female from New Orleans differs in having a narrower rostrum, with the margins parallel and the tip more acute. The first pair of abdominal legs, ordinarily bearded at the margins and flattened, are singularly transformed. They are thicker, cylindrical, with the tip narrower and twisted, as is the case with the abdominal legs of *Astacus fluviatilis*. The postabdomen is narrower at the base. Possibly this specimen is a sterile female.

Another female, in shape and size similar to the foregoing (3.2 inch. long) has the rostrum broader, the margins not so much thickened as in the type, the acumen more acute. The hand is more flattened and not so strongly dotted, the inner margin more rounded, with six strong and separated teeth, giving to the specimen a very peculiar aspect. The two anterior spines of the inner margin of the carpus are long and more developed. The annulus between the fourth pair of legs has its anterior margin irregularly tuberculated. The right hand is wanting; I regard the specimen as abnormal and deformed.

Cat. No. 165, Belleville, Ill., Dr. Engelmann. Fem. Spec. 2.

Cat. No. 1461, Evanston, Ill. Male. Spec. 1.

Cat. No. 195, Lawn Ridge, Ill., Mr. A. Ordway. Fem. Spec. 1.
Cat. No. 197, Lawn Ridge, Ill., Mr. A. Ordway. Male. Fem. Spec. 6.
Cat. No. 1848, Petersburg, Va. Fem. Spec. 1.
Cat. No. 229, Arkansas, Mr. G. Stolley. Male. Spec. 1.
Cat. No. 242, New Orleans, Mr. Lawrence. Fem. Spec. 1.
Dry Spec. Lake Michigan, Professor C. Marey. Fem. Spec. 1.

27. Cambarus Nebrascensis *Girard.*

Cambarus Nebrascensis Girard, Proc. Philad. Acad. N. Sc., No. 10, T. 6, p. 91.

"Rostrum intermediate in form between that of *C. robustus* and *C. Diogenes*." "Dorsal lines of suture of the carapace in close contiguity. Large claw nearly conical, giving to the species a very peculiar aspect." "Fort Pierre, Nebraska; collected in 1850 by Thaddeus Culvertson." — Girard.

I have never seen any *Cambarus* agreeing with the description given by Mr. Girard, and I have not seen a typical specimen of *C. Diogenes*, the species compared with *C. Nebrascensis*. I have spoken of all the species of *Cambarus* with a linear areola under *C. maniculatus*. None of these several species agrees with the description given of *C. Nebrascensis*.

28. Cambarus latimanus *LeConte.*

Astacus latimanus LeConte, Proc. Acad. Philad. N. Sc., T. 7, p. 402.

Figures on Pl. I. and III.
First abdominal leg of the male:
first form, fig. 43 in front; fig. 44 outside.
second form, fig. 45 in front; fig. 46 outside.
Antennal lamina, fig. 162, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro brevi, basi lato, tum sensim angustiori, fere triangulari, ante apicem leviter sinuato, acumine brevi, acuto; rostro supra excavato, basi foveolato; marginibus lineato punctatis; acumine vix marginato; cretis parvis, postice subdivergentibus, extus linea impressa, antice obtusis. Antennis gracilibus, thorace longioribus, articulis duobus basalibus dentibus externis parvis acutis; antennis internis articulo basali dente infero anteapicali parvo; lamina brevi, angusta, apice latiori, margine externo inflato, spina acuta apicali. Epistomate latiori, antice truncato, spina parva media; lateribus obliquis, angulis obtusis; pedibus maxillaribus externis intus barbatis. Thorace leviter ovato, parce punctato, lateribus granulosis vel tuberculosis; linea profunda, sinuata, spina utrinque laterali modica vel obsoleta; spina antica infera submulla; areola modica, plana, antice paululum carinata, postice latiori. Postabdomine vix angustiori, lævi, segmentis anteapicalibus angulis ex-

terms obtusis; lamina media parte utrinque bispina, parte apicali, sublongiori, elliptica. Pedibus anticis brevibus, latis; chela lata plana, ciliato-punctata; subtus lævi, ad marginem internum sulcata; margine interno brevi, incurvo, tuberculoso-serrato; digitis duplo longioribus, latis, rectis, bicostatis, lineato-punctatis, ciliatis; digito mobili extus et basi intus tuberculato; digito externo basi intus tuberculato, extus marginato, punctato. Carpo lato, oblique truncato, parce punctato, intus subtuberculoso, spina interna media valida, interdum alia basali parva; subtus spinis duabus obtusis anticis, tertia minori interna. Brachio brevi, lævi, spinis duabus anteapicalibus oblique positis, subtus spinis biseriatis acutis. Pedibus tertiis articulo tertio unguiculato; quartis capitulo basali, ovoideo, quintis submullo. Pedibus abdominalibus brevibus, validis, contortis; intus latis, planis; extus medio crassioribus; parte interna breviori, cylindrica, apice inflexa, conica, acumine parvo, compresso; parte externa dente longo apicali subito incurvo, extus fusco-corneo, striato.

Forma II. differt chela plerumque lævіori; pedibus abdominalibus basi articulatis; parte interna apice obtusiori; parte externa dente apicali latiori, vix separato, breviori, obtuso, extus nec fusco-corneo nec striato.

Marem vidi magnum pedibus abdominalibus similibus sed basi non articulatis; chelis magnis, lævioribus, digitis angustioribus.

Femina differt abdomine latiori, basi angustato; ventre inter pedes quartos nudo; annulo transverso, modice crasso, lumine denticulato posteriori, sulco anteriori longitudinali.

(Maxim.) Long. corp. 2.9; antenn. 2.5; ped. antic. 2.3.

Habitat: Athens, Georgia; South Carolina.

Vidi specimina multa et juniora.

Juniores lævіores, acumine variabili, rostro interdum longiori.

I have examined a female type in the Mus. Acad. Philad. of *C. latimanus* LeConte. It is the largest seen by me, and has the dimensions given by Mr. LeConte, long. corp. 3.3.

Cat. No. 236, Athens, Ga., Dr. J. LeConte. Male. Fem. Spec. 12.*

Cat. No. 1849, Milledgeville, Ga. Male. Spec. 1.

Dry Spec., South Carolina, Mr. L. R. Gibbes. Male. Spec. 1; labelled *A. Bartonii* Gibbes.

29. Cambarus Mexicanus *Erichson.*

Cambarus Mexicanus Erichson, Wiegmann's Archiv, No. 20, T. 12 p 99.

"Chelis granulatis, gracilibus, subcylindricis, carpis muticis, rostro lato, apice obtusiusculo."

"Thorax somewhat compressed, always densely punctulated; cretæ prominent, divergent behind; rostrum nearly flat, broad, obtuse at the

apex, with sharply recurved margins; lamina of the antennæ broad, with a little apical external spine. Hands narrow, nearly cylindrical, densely scabrous; the fingers a little shorter than the hands, thin; carpus longer than broad, scabrous, without spines on the inner side and beneath. Postabdomen nearly as broad as the thorax. The third pair of legs in the male hooked. Long. corp. nearly 2 inch. Mexico." — Erichson.

I have not seen this species. The hands resemble in shape those of *C. Nebrascensis*.

C. Montezumæ Saussure, Revue et Magas. Zool., T. 9, p. 102, and Mém. Soc. Phys. Genève, T. 14, Pl. II, fig. 22, p. 459, from the marshes of the valley of Mexico, Chapultepec, seems to be the young of *C. Mexicanus*. It is always difficult to identify or to separate species by the descriptions, but I cannot find any difference in the description given by Mr. DeSaussure. It is said that the males of *C. Montezumæ* have hooks on the second and the third pair of legs, and I have seen the same aberration in some species of this group.

30. Cambarus Cubensis *Erichson.*

Cambarus Cubensis Erichson, Wiegmann, Archiv, T. 12, p. 100, n. 21.

"Chelis granulatis, gracilibus, subcylindricis, carpis muticis, rostro lato, apice acuminato.

"Very similar to *C. Mexicanus*. Thorax punctulated; cretæ visible, a little divergent behind; rostrum nearly flat, broad, sharply notched on each side in front. Lamina of the antennæ very broad, nearly truncated before in front, with a little apical external spine. Hands shorter, narrow, nearly cylindrical, delicately scabrous; fingers slender; carpus scabrous, with sharp spines on the inner side; postabdomen nearly as broad as the thorax. The third pair of legs in the male hooked. Long. corp. 2.3 inch. Cuba." — Erichson.

I have not seen any species or specimen from Cuba. Perhaps this species belongs to the first group. The words in Erichson's description, literally "rostrum on each side notched in a sharp spine," translated by me "sharply notched," are doubtful. *C. consobrinus* Saussure, from the same locality, has the rostrum with anteapical spines. I know nothing more about these two species.

C. consobrinus Saussure, Revue et Magas. Zool., T. 9, p. 101, and Mém. Soc. Phys. Genève, T. 14, Pl. II, fig. 21, p. 458, from the marshes in the interior parts of Cuba, cannot be separated from *C. Cubensis* by the description. Apparently Mr. DeSaussure has seen the two forms of the male; this supposition would explain his remarks concerning the differences in the hands. But not having seen any specimens from Cuba, I am unable to give a definite judgment.

31. Cambarus advena *LeConte.*

Astacus advena LeConte, Proc. Acad. Philad., T. 7, p. 402.

Figures on Pl. I., III., and VII.
First abdominal legs of the male:
first form, fig. 90 in front; fig. 91 augmented; fig. 92 outside.
Antennal lamina, fig. 164, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.
Pl. VII. Male, first form.

Mas. Rostro lato, paululum longiori, fere triangulari, apice subito acuminato breviori; supra excavato, sparsim punctato, basi foveola latiori; marginibus obliquis, ad acuminis apicem non interruptis; cretis vix separatis, parum elevatis, extus obsolete sulcatis, antice obtusis, postice subdivergentibus. Antennis thorace paulo brevioribus, articulis duobus basalibus dente nullo; antennis internis articulo basali dente infero acuto medio; lamina brevi, rostri longitudine, angusta, margine externo inflato, spina apicali acuta; margine cephalothoracis angulo oculari nullo. Epistomate latiori, margine antico recto, spina media parva lateribus obliquis; pedibus maxillaribus externis intus longe barbatis. Thorace angusto, compresso-cylindrico, lævi, parce sed profunde punctato, lateribus granulis rarioribus; linea profunda, sinuata, lateribus fissa, spina antica infera ad antennarum basin; areola profunda, media fere nulla, lineari, antice posticeque profunda, triangulari, dilatata. Postabdomine angusto, lævi, lateribus parallelis, segmentis antepenultimis angulis externis subrotundatis; lamina media antice utrinque bispina, parte apicali breviori, rotundata, lamina laterali costa media usque ad marginem integra, spina marginali. Pedibus anticis modice longis validis; chela lata, inflata, parce punctata, margine externo obsolete dentato; margine interno longo, incurvo, subtus paulo sulcato, fortiter et acute serrato-dentato; margine externo obsolete dentato digitis vix longioribus, validis rectis, costatis, intus dentatis, digito mobili basi extus tuberculato. Carpo lato, oblique truncato, intus tuberculato, spina interna, subantica majori; alia minori basali (in adultis spinis nonnullis minoribus internis); subtus spinis duabus anticis obtusis; brachio modice longo, oculos superanti, lævi, margine supero tuberculato, spinis duabus anteapicalibus oblique positis acutis; subtus biseriatim spinoso; pedibus tertiis articulo tertio unguiculato; pedibus quartis capitulo basali nullo. Pedibus abdominalibus longis, gracilibus, contortis, parte interna cylindrica recta, apice acuta, longiori, extus curva; parte externa sublongiori, apice dentibus duobus fusco corneis incurvis coadunatis, lamina compressa ovali, externa recurva.

Femina differt, chelis antennisque brevioribus, abdomine lato, basi thorace fere latiori; ventre inter pedes quartos lævi; annulo transversali lumine profundo, obcordiformi.

Long. corp. 2.2 ad 2.9; antenn. 1.4; ped. antic. 1.7 ad 2.

Habitat: Charleston, S. C.; Georgia; Mobile, Ala.

I have seen male and female.

This species is remarkable for the lateral lamina of the postabdomen. In the allied species the middle rib terminates in a spine before the margin; in this species the rib ends exactly on the margin, and the spine is acute and marginal.

I have compared a female type in the Philadelphia Museum. This is the largest specimen I have seen.

It differs from the *C. Carolinus* in the short and anteriorly dilated lamina of the antennæ, with a short external spine; in the teeth of the first joint of the interior antennæ, in the anterior spine at the end of the thoracic line. In the larger specimens the hand is more sulcated beneath at the inner margin, and the carpus more spinulose.

I have seen many young specimens, but only one very young male of the second form. The abdominal legs are in their first stage of development. The tip is cylindrical, simple, and a little incurved.

Cat. No. 282, Georgia, Dr. Jones. Male. Fem. Spec. 6.

32. Cambarus Carolinus *Erichson.*

Cambarus Carolinus Erichson, Wiegm. Arch., T. 12, p. 96, n. 16.

Figures on Pl. I. and III.
First abdominal legs of the male:
first form, fig. 51 in front; fig. 52 outside.
second form, fig. 53 in front; fig. 54 outside.
Antennal lamina, fig. 165, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Rostro longiori, lato, triangulari, antice deflexo, excavato, parce punctato, serie punctorum marginali, marginibus elevatis ad acuminis acuti apicem non interruptis; cretis parvis, sulcatis, antice muticis, subdivergentibus, postice callosis, convergentibus. Antennis gracilibus, thorace paulo longioribus, dentibus articulorum basalium nullis; lamina parva, angusta, margine externo inflato, spina apicali longiori. Epistomate lato, antice obtuso triangulari, lateribus obliquis, subsinuatis; pedibus maxillaribus externis intus barbatis. Thorace compresso, supra subdepresso, sparsim sed profunde punctato, lateribus granulosis; linea profunda, sinuata, lateribus fissa, spina antica infera nulla; areola angusta, plana, media submulla, lineari, postice triangulari majori punctata. Postabdomine angusto, thorace sublongiori, parce punctato; segmentis antepenultimis angulis lateralibus rotundatis; lamina media utrinque bispina, parte apicali breviori, rotundata. Pedibus anticis brevibus, latis, chela brevi, lata, subinflata, paulo lanuginosa, punctata; margine interno curvato, serrato dentato, subtus sulcato; margine externo obsolete dentato; digitis fere æqualibus, validis, nec longioribus, rectis, costatis, lineato-punctatis, intus tuberculato-dentatis; digito mobili basi extus tuberculato. Carpo lato, oblique truncato, parce punc-

tato; latere interno tuberculato-spinoso, spina media majori; subtus spinis duabus anticis modicis. Brachio brevi, margine supero spinoso, spinis duabus anticis oblique positis majoribus; subtus biseriatim spinoso. Pedibus tertiis articulo tertio unguiculato; pedibus quartis capitulo basali orbiculari. Pedibus abdominalibus gracilibus, rectis, parte interna angustiori cylindrica, apice acuta elongata; parte externa apice subinflata, dente fusco-corneo, extus striato, triangulari, compresso, acuminato.

Forma II. Pedibus abdominalibus basi non articulatis, parte interna apice crassiori, breviori; parte externa apice magis inflata, brevi, conica, subacuta, nec fusco-cornea.

Femina abdomine vix latiori, ventre inter pedes quartos nudo; annulo fere orbiculari, antice subbituberculato, lumine centrali.

Long. corp. 2.1; antenn. 1.3; ped. antic. 1.4.

Habitat: Georgia; Carolina (Erichson).

I have seen twenty specimens; the males are younger, the male Forma II. is very young; its abdominal legs are not articulated, nevertheless it has the shape commonly observed in the second form.

This species is similar to *C. obscura*, but differs as follows: the rostrum is more triangular, the thorax strongly punctulated, the areola not impressed; the apical part of the median lamina is longer, the rib in the lateral lamina ends before the margin; there are no spines at the basal joints of the smaller antennæ; the carpus beneath and on the inside has numerous spines; the lateral margins of the postabdomen are not straight, but every segment is more rounded on the outside; the sexual parts differ visibly.

I think this species is the *C. Carolinus* Erich. The description seems to agree very well; the obviously small postabdomen, the more pointed lamina of the antennæ, and the linear areola are the chief characters mentioned by Erichson. The subsequent addition, that the males have only the third pair of legs hooked, places the *C. Carolinus* without doubt in this group. All the other species of the group, except *C. obesus*, are immediately seen to differ in having a larger areola, but the enlarged postabdomen separates them from the species described by Erichson.

Cat. No. 232, Charleston, S. C., Professor L. Gibbes. Male. Fem. Spec. 2.

Cat. No. 1850, Georgia. Male. Spec. 1.

Cat. No. 230, Mobile, Ala., Mr. Forbes. Male. Fem. Spec. 12.*

Cat. No. 275, Mobile, Ala., L. Agassiz. Male. Spec. 1.

Dry Spec., Georgia, L. Agassiz. Male. Spec. 1.

ASTACUS.

Corpore robusto; pedibus quintis branchiis gerentibus; antennis internis flagello breviori, inæquali; aure conico postice aperto; pedibus maris tertiis et quartis inermibus; pedibus abdominalibus maris simplicibus; femina annulo ventrali solido.

Having already given the differences of the genera *Astacus* and *Cambarus*, I need not here repeat them.

In its general form the species of *Astacus* are clumsy and oval. The fifth pair of legs has a gill, but without the broad, deeply folded membrane peculiar to the gills of all the other legs, which possess also a basal external bundle of shorter and irregularly placed gill-tubes. The inner antennæ are short, their bases thick, the joints more spherical and calcareous. The exterior antennæ are shorter than the body; their lamina is prismatic, being more thickened on the external border. The epistoma is solid, conical, a little contracted in front of the tip. The ear forms an elevated cone, rounded at the top, with a narrower circular tympanum behind. The areola is broad and slightly marked. The postabdomen is always broad, the exterior angles of the segments are often elongated and acuminated. The third and the fourth pair of legs in the males never differ from the other legs, and are never hooked. The first abdominal legs in the male form a corneous, not articulated limb, with the apical half dilated and rolled from the outside inward, forming also a channel. The shape of these legs seems not to vary in the different species, at least no difference is as yet known. In the second pair of abdominal legs the inner flagellum with the dilated basal half is rolled from the inside outward, or it has exactly the form of that of the first abdominal legs, as in the European species, or it is of a more triangular shape, similar to the *Cambarus*, as in the American species. The separated and perforated annulus ventralis behind the fourth pair of legs of the females, described in *Cambarus*, is not to be found in *Astacus*. In fact, the same part exists here, though in the European species it is never separated, but forms only a slender transverse ridge, which in the American species is curved behind like a horseshoe. In the American species it is far more dilated behind in a triangular manner, excavated beneath, and apparently more similar to *Cambarus*, but neither separated nor perforated. As yet no dimorphism of the males is known, and nothing of burrowing habits in the species. It seems striking, as already mentioned, that the species of *Astacus*, especially those from Europe, offer so many varieties, which are rarely found, considering the great number of species in the American *Cambarus*. At the same time I expressly remark, that none of the characters set forth as variable in the European species is used by me to characterize and to separate the American species.

Concerning the further division of the genus *Astacus* into groups, I am not able to give a final judgment, being entirely ignorant of the Australian species, and having before me of the Amur species but one female, and of the European species only *Astacus fluviatilis*.

The European species, or more precisely *Astacus fluviatilis*, differ from all the others in having the apical part of the intermediate lamina of the postabdomen separated from the basal half, although not so strongly as in *Cambarus*; in the American and Asiatic species this part is only more or less separated at each side, it is most so in *A. Trowbridgii*.

A. fluviatilis has a basal tooth on the exterior margin of the antennal lamina, which is never to be found in any other species. This apparently very striking character is never mentioned for *A. fluviatilis*.

The Asiatic species, *A. Dauricus*, differs in having a rostrum similar to that of *C. Bartonii*, the front border of the cephalothorax strongly angulated, a narrower and more elongated thorax, with a nearly straight, transverse suture and the above-mentioned form of the annulus ventralis.

The American species are divided according to the following characters: —

I. Margins of the rostrum denticulated; front border of the cephalothorax slightly angulated.

1. Rostrum not notched in front of the tip; cretæ visible; hands barbated: *A. Gambelii*.

2. Rostrum strongly notched before the tip; no cretæ, but two spines on each side; hands without beard: *A. nigrescens*.

II. Margins of the rostrum not denticulated; front border of the cephalothorax straight.

1. Rostrum long, margins parallel, strongly notched in front of the tip: *A. Trowbridgii*.

2. Rostrum short, tapering, slightly notched before the tip: *A. Klamathensis*.

I have not seen *A. leniusculus*, which differs from both the preceding species in the acute angles of the segments of the postabdomen.

My knowledge is too limited and fragmentary to authorize my saying more respecting the geographical distribution of the species.

1. Astacus Gambelii *Girard.*

Cambarus Gambelii Gir., Proc. Acad. N. S. Philad., T. 6, p. 90; p. 375; p. 380. — Stimpson, Proc. Boston Soc. N. H., T. 6, p. 87 (separat. p. 52).

Figures on Pl. I., III., and XI.
First abdominal leg of the male:
first form, fig. 97 in front; fig. 98 outside.
Antennal lamina, fig. 170, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.
Pl. XI. Male type from California.

Mas. Pallidus obesus, rostro modico triangulari, subplano, medio

calloso-carinato, marginibus subcallosis 10-dentatis, acumine parvo, acuto, recurvo; cretis brevibus, impressis, antice subacutis. Antennis modicis (apex deest); articulis duobus basalibus dente externo brevi acuto; antennis internis articulo basali dente infero anteapicali acuto; lamina valida trigona, rostri sublongiori, angusta, margine externo sinuato, crasso, apice spina acuta breviori. Epistomate parvo, acute triangulari; pedibus maxillaribus externis intus barbatis. Thorace ovato, depresso, parce punctato, læviori; linea sinuata, modice profunda; areola lata. Postabdomine thorace non latiori, lævi, segmentorum angulis externis subacutis; lamina media parte basali quadrangulari apice utrinque bispina; parte apicali breviori, rotundata, margine apicali rotundato integro (mas alter parte basali apice angustiori, utrinque unispinoso; parte apicali brevi rotundata, margine medio exciso); lamina laterali costata. Pedibus anticis validis, longis, spinulosis; chela magna, elongata, subplana, marginibus subacutis, rectis; supra ad marginem internum et externum sulcata ac densius barbata; digitis validis, rectis, conicis, chela non-longioribus. Carpo lato, truncato, intus scabro; subtus spina media antica parva. Brachio supra ante apicem spinuloso, subtus biseriatim spinuloso, spinis ad articulationem obsoletis. Pedibus abdominalibus brevibus, rectis, dimidio apicali circumvolutis, apice truncatis.

Long. corp. 3.2″; ped. antic. 3″.

Habitat: California.

I have seen two males taken by the late Dr. Gambel in California, and communicated by the Academy of Philadelphia; these same males were examined at an earlier day by Professor L. Agassiz (Proc. Acad. Philad., T. 6, p. 375).

This species is very remarkable in having tufts of fine erect hair on each side of the hands, giving to the species a very peculiar aspect. The triangular rostrum with dentated margins and the acumen only represented by a similar, but little stronger tooth, instantly separate *A. Gambelii* from the other Western species. In the second pair of abdominal legs the palpus of the penultimate joint is not longer than the leg, though this palpus in *A. nigrescens* is much longer.

Mr. Girard, l. c. p. 91, says: "Anterior pair of abdominal legs elongated resembling somewhat in shape those of *C. robustus*, to which it bears a close relationship." But the type of *C. robustus* in the Philadelphia Academy is very near *C. Bartonii*, while its abdominal legs are very different. Also *C. robustus* possesses no gills on the fifth pair of legs, and is quite unlike *A. Gambelii*.

Of the two males seen by me, one has the intermediate lamina of the postabdomen rounded at the tip, the other strongly and regularly notched. I regard the last as an accidental variety.

2. Astacus nigrescens *Stimpson.*

Astacus nigrescens Stimpson, Proc. Boston Soc. N. H., T. 6, p. 87 (Separat p. 52).

Figures on Pl. III.
Antennal lamina, fig. 168, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Mas. Obesus, obscure olivaceus; rostro longo, valido, basi latiori, antice fere parallelo, acumine triangulari, longiori acuto, subrecurvo; supra medio canaliculato basi callo obsoleto in fovea antice angulata; marginibus calloso-inflatis, sex vel octo-dentatis; loco cretarum dentibus utrinque tribus acutis. Antennis validis, corpore brevioribus, articulis duobus basalibus dente externo acuto; antennis internis articulo basali dente infero anteapicali acuto; lamina valida trigona, rostri longitudine, modice lata, margine externo crasso, inflato, apice spina longa acuta. Epistomate lato, subtus carinato, antice triangulari; pedibus maxillaribus externis subtus spinulosis, intus barbatis. Thorace ovato, depresso, densius et fortiter punctato, lateribus granulosis; linea lata profunda, utrinque subsinuata; areola lata, plana, antice latius dilatata. Postabdomine lato, fere lævi, segmentorum angulis externis elongatis acutis; lamina media parte basali quadrangulari; apice utrinque spinis duabus validis, subrejectis; parte apicali minori, angustiori, elliptica, margine antico exciso; lamina laterali vix costata, spina media antemarginali, externaque marginali. Pedibus anticis validis, longis, corpore paulo brevioribus; chela magna, elongata, subplana, marginibus subacutis, densius punctata, margine interno fere recto, subtus paulo depresso; digitis validis, rectis, chelæ longitudine, conicis, apice spinulosis. Carpo lato, granuloso, antice truncato, subtus spina media valida. Brachio lævi, margine antico et superiori spinoso, spina apicali majori, subtus biseriatim spinuloso, spina antica aliaque utrinque ad articulationem majoribus. Pedibus abdominalibus, brevibus, rectis, dimidio apicali cylindrico circumvolutis, apice truncatis.

Femina differt ventre inter pedes quartos lævi, canaliculato; annulo bifido laminato.

(Maxim.) Long. corp. 4.6; antenn. 3; ped. antic. 4.2.

Habitat: San Francisco, California.

I have seen eight males and one female; the fifth pair of legs has branchiæ. Male and female type communicated by Professor Stimpson.

This species and *A. Gambelii* are separated from the others by the denticulated rostrum.

Cat. No. 228, San Francisco, Cal., Mr. T. G. Cary. Male. Spec. 4.

Cat. No. 1851, California, Mr. T. G. Cary. Male. Spec. 1.

3. Astacus Trowbridgii *Stimpson.*

Astacus Trowbridgii Stimpson, Proc. Boston Soc. N. H., T. 6, p. 87 (Separat. p. 53).

Figures on Pl. III. and X.

Antennal lamina, fig. 171, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*. Pl. X. Female type.

Fem. Obesa, olivacea, chelis obscurioribus; rostro lato longo, excavato, parce punctato, medio obsolete canaliculato, lateribus parallelis, marginatis, crassioribus; acumine triangulari, longo, angusto, acuto, fusco-corneo, spinis lateralibus validis; cretis brevioribus, antice spina rejecta; aliaque ad basin cretæ spina. Antennis corpore brevioribus modicis, articulis duobus basalibus dente externo valido; antennis internis articulo basali dente infero apicali, lamina valida, trigona rostro breviori, modice lata, margine externo crasso, apice spina longa, acuta. Epistomate triangulari; pedibus maxillaribus externis intus barbatis. Thorace ovato, antice angustiori, densius punctato, lateribus sublævibus; linea profunda, sinuata; areola lata. Postabdomine thorace latiori, apicem versus decrescente, lævi, angulis segmentorum externis rotundatis; lamina intermedia quadrangulari, apice, angustiori, utrinque spinis duabus validis, rejectis; parte apicali breviori, fere orbiculari; lamina laterali vix costata, spina media antemarginali, externaque marginali. Pedibus anticis validis, longis, corpore brevioribus; chela magna, lata, punctata subplana, marginibus subacutis, margine interdum recto subtus excavato; digitis validis, subsinuatis, chela paulo longioribus, apice spinulosis; digito mobili intus basi exciso; externo digito basi intus producto; utroque intus dentato. Carpo lato, truncato, punctato, spina antica interna acuta; subtus spina media antica. Brachio, sublævi, margine antico et superiori spinoso, spina anteapicali majori; subtus biseriatim forte spinoso, utrinque ad articulationem spina valida. Ventre inter pedes quartos lævi; annulo transverso, cylindrico.

Long. corp. 4; antenn. 3; ped. antic. 3.

Habitat: Astoria, Oregon; "near Astoria it occurs sometimes abundantly in brackish water."

I have seen two female types of Mr. Stimpson's, communicated by the Museum of the Soc. Nat. Hist. in Boston.

This species differs from *A. nigrescens* in the broad, rounded lateral angles of the abdominal segments.

4. Astacus Klamathensis *Stimpson.*

Astacus Klamathensis Stimpson, Proc. Bost. Soc. N. H., T. 6, p. 87 (Separat. p. 52). — Bate Spence. Naturalist in Vancouver's Island and Brit. America, 1866, T. 2, p. 278.

Figures on Pl. III.

Antennal lamina, fig. 169, *a*; epistoma, *b*; spine of the second joint of the exterior antenna, *c*.

Fem. Rostro longo, densius punctato, subplano, medio obsolete

canaliculato, antice angustiori, utrinque marginato, acumine modico, acuto, spinis lateralibus parvis; cretis brevioribus, spina antica perparva, postica nulla. Antennis corpore brevioribus (apex deest) articulo primo dente valido, secundo submullo; antennis internis articulo basali dente infero subapicali, lamina valida, trigona, rostro breviori, lata, margine externo crasso, apice spina brevi, acuta. Epistomate triangulari; pedibus maxillaribus externis intus barbatis. Thorace ovato, antice angustiori, densius punctato, lateribus granulosis; linea profunda, sinuata; areola lata. Postabdomine thorace latiori, apicem versus decrescente, lævi, angulis segmentorum externis rotundatis, lamina intermedia quadrangulari, apice subangustiori, utrinque spinis duabus validis rejectis; parte apicali breviori, rotundato; lamina laterali vix costata. Pedibus anticis modicis, brevibus; chela modica, punctata, subplana, marginibus subacutis, margine interno recto, subtus excavato; digitis validis, subrectis, chelæ non longioribus, apice spinulosis, non dentatis. Carpo lato, truncato, punctato, intus mutico; subtus spina media antica parva. Brachio sublævi, spina anteapicali majori, subtus biseriatim spinoso, utrinque ad articulationem spina interna valida. Ventre inter pedes quartos lævi, annulo transverso, cylindrico, bipartito.

Long. corp. 3″; ped. antic. 2.1″.

Habitat: Klamath Lake, California; in all streams east of the Cascades. Sp. Bates.

I have seen only one female type, in bad condition, communicated by Dr. W. Stimpson.

It may be distinguished from *A. Trowbridgii* by its stronger and more punctulated thorax, its tapering rostrum, with less developed spines, the shortly spined antennal lamina, the smaller hands, the carpus without internal apical spine; the annulus between the fourth pair of legs divided in the middle.

The accurate determination of this species requires the examination of more specimens; the antennal lamina on the right side is accidentally abnormal, perhaps the other is also a little changed in shape.

5. Astacus leniusculus *Dana.*

Astacus leniusculus Dana, Proc. Acad. N. H. Philad., T. 6, p. 20. — U. S. Exploring Exped. Crustac., T. 1, p. 524, t. 33, fig. 1. — Stimpson, Proc. Boston Soc. N. H., T. 6, p. 87.

"Rostrum tridentatum, dentibus acutis, medio tenuiter elongato. Carapax lævis, punctulatus, lateraliter pone rostrum utrinque bi-spinosus; areola inter suturas longitudinales postdorsales lata. Pedes antici compressi, inermes, non tuberculati, manu lævi, punctulata, carpo paulo oblongo, intus recto, inermi, apice interno acuto excepto; brachio antice denticulato, apice interno elongate acuto, dorso unispinoso. Pedes sequentes nudiusculi. Segmentum caudale parce oblongum, lateribus

fere parallelis. Pedes 5ti branchias parvas gerentes. Hab. flumine Columbiæ," Oregoniæ. Long. 4″. — *Dana.*

In the description Mr. Dana says, "arm with anterior margin denticulate, and a longer tooth at apex, on *outer* margin, short distance from apex, unispinous."

"May be recognized by its well-developed thoracic spines, and light color. Has a general resemblance to *A. Trowbridgii*; differs from that species in having more prominent thoracic spines; the rostrum is somewhat shorter and broader, the dorsal area broader." — *Stimpson.*

Habitat: Columbia River; Puget Sound.

I have not seen this species, which seems to be very similar to *A. nigrescens*, except in the non-denticulated margin of the rostrum. The description and the figure given by Mr. Dana are not sufficient.

6. Astacus Oreganus *Randall.*

Astacus Oreganus Randall, Journ. Acad. N. S. Philad., T. 8, Pl. I., p. 138, t. 7. — Erichson, Wiegm. Arch., T. 12, p. 375. — Girard, Proc. Acad. N. S. Philad., T. 6, p. 87. — Stimpson, Proc. Boston Soc. N. H., T. 6, p. 87 (Separat. p. 55).

"Body fuscous, granulated, carpus with a sharp spine at the interior angle; arm produced into a spine on each side anteriorly; thorax behind the front with five spines, placed three before and one on each side behind the lateral ones; a large reddish spot on each side posteriorly; front little reflected on the sides, terminating in a very long, slender spine, and having a short, marginal spine on each side. Long. 4″. Columbia River.

"Testa granulata, bimaculata, fronte valde producta." — *Randall.*

Erichson, in his translation of this description, makes a mistake. "das Magenfeld an jeder Seite mit fuenf Dornen, naemlich drei vor und zwei hinter den Seitendornen"; Randall by no means says that there are five spines on each side.

"Dr. Randall's single specimen of this species was unfortunately lost by the artist employed in delineating it. No other example has been since found, although its locality has been since repeatedly searched. If the figure in the eighth volume, etc., is correct, this is a very remarkable species, differing from all others known, in possessing a median thoracic spine as well as in the length of the terminal rostral tooth, and above all in the singular lateral appendages of the abdominal segments." — *Stimpson.*

The figure published by Randall is without doubt very incorrect, giving one segment too much in the postabdomen, and a little claw at the tips of the fourth pair of legs. The curious lateral appendages to the segments of the postabdomen are probably its lateral angles, acute as in *A. nigrescens*, or the artificially protruded abdominal legs. Mr. Ran-

dall would have mentioned these very curious organs in his description if they had really existed. The tail is apparently very poorly figured, but the strong spines at the apex of the intermediate lamina are directed outward as well as in the lateral lamina and the base in the same manner as in *A. nigrescens* and *Trowbridgii*. I think the spine in the middle of the base of the beak is not at all a spine, but merely a carinated elevation very badly figured. *A. nigrescens* has a similar but not so well produced elevation; the spines could not have been very prominent, as the painter did not figure them at all. It is possible that the form of the carpus and brachium is as badly exaggerated. The exterior antennæ are apparently too short, and the length of the rostrum, so much longer than the peduncle of the antennæ, is probably erroneous; the lamina of the antennæ is figured as *triarticulate!* I think the characters quoted make it evident that the figure is without scientific value.

It is impossible to recognize this species, from an incomplete description and a very inadequate figure. The general appearance (although the mesothorax is very short) seems to point to a species near *A. leiusculus* and *Trowbridgii*, both being from the same locality, while the outwardly directed spines on the tail are truly characteristic of this group. The rostrum has the shape of *A. leiusculus*. The position of the five spines behind the front is very doubtful, and probably Erichson intended to give by the figure, which shows the little marks on each side, a more correct view of their position. The apparent incorrectness induces me to think that *A. Oregonus* can be no other than *A. leiusculus*, or else is to be struck out entirely.

ON THE GEOGRAPHICAL DISTRIBUTION.

The several different species mentioned have the following distribution: —

Genus CAMBARUS.

GROUP I.

1. C. acutus.
Louisiana: New Orleans, Milliken's Bend.
Alabama: Mobile.
South Carolina: Charleston, Summerville.
Missouri: St. Louis.
Mississippi: Kemper County.
Virginia: James River.

Var. A.
Illinois: Lawn Ridge, Basson Pudge, Evanston, Peoria, Athens.
Indiana.

Var. B.
North Carolina: Beaufort.
New Jersey: Essex.
New York.

2. C. Clarkii.
Louisiana: New Orleans.
Texas: between San Antonio and El Paso del Norte.

3. C. troglodytes.
South Carolina: Charleston.
Illinois: Lawn Ridge.
Georgia.

4. C. Blandingii.
South Carolina: Camden.

5. C. fallax.
Florida.

6. C. Lecontei.
Alabama: Mobile.
Florida: Pensacola.
North Carolina: Beaufort.
Georgia: Milledgeville.
Mississippi: Root Pond.

7. C. spiculifer.
Georgia: Athens, Roswell.

8. C. angustatus.
Georgia: Georgia inferior.

9. C. versutus.
Alabama: Mobile, Spring Hill.

10. C. maniculatus.
Georgia: Georgia inferior.

11. C. penicillatus.
South Carolina: Charleston.
Georgia.

12. C. Wiegmanni.
Mexico.

13. C. pellucidus.
Kentucky: Mammoth Cave.

GROUP II.

14. C. lancifer.
Mississippi: Root Pond.

15. C. affinis.
Pennsylvania: Delaware, near Philadelphia, Pittsburg, Carlisle, Reading, Schuylkill River, Erie.
Maryland: Havre de Grace.
District of Columbia: Potomac at Washington.
New Jersey.
New York: Niagara.

16. C. virilis.
British America: Lake Winnipeg, Saskatschavan, Red River, Lake Superior, Toronto.
Illinois: Quincy.
Iowa: Davenport.
Wisconsin: Sugar River.

Var. A.
Iowa: Davenport, Burlington.
Missouri: Osage River.
Ohio: Dayton, Miami River.
Texas.

17. C. placidus.
Illinois: Quincy.
Tennessee: Lebanon.
Texas.

18. C. juvenilis.
Kentucky: Little Hickman, Kentucky River.
Missouri: Osage River.

19. C. propinquus.
Canada: Lake Superior.

C. propinquus — *Continued.*
New York: Lake Oneida, Rochester, Niagara, Grass River, Lake Ontario, Four-Mile Creek, Oswego, Garrison Creek, Sackett's Harbor.
Illinois: Ogle County.
Indiana: Delphi.

20. C. obscurus.
New York: Genessee River, Rochester.
? Virginia: (*A. fossor* Raf.)
? Pennsylvania: (*A. fossor* Raf.)

21. C. rusticus.
Ohio: Cincinnati.
Canada: Lake Superior.

22. C. immunis.
Illinois: Belleville, Lawn Ridge.
Alabama: Huntsville.
North Carolina: Beaufort.

23. C. extraneus.
Georgia: Tennessee River.

GROUP III.

24. C. Bartonii.
Canada: Lake Superior.
Vermont: in most of the small streams in the western part of the State.
New York: Lake Champlain, Elizabethtown, Berkshire, Fishkill, Newburg, Western New York.
New Jersey: Schooley's Mountain.
Pennsylvania: Philadelphia, Schuylkill River, Berwick, Hammetstown.
Ohio: Cincinnati, Sciota River, Columbia.
Kentucky: Hickmann's Landing, Kentucky River, Mammoth Cave.
District of Columbia: Georgetown.

C. Bartonii — *Continued.*
Missouri: Osage River.
Virginia: Greenbrier River.

25. C. robustus.
Canada: Toronto, Humber River.
New York: Genessee River, Rochester, Lake Regis, Adirondack Region.
Virginia: Fredericksburg.

26. C. obesus.
Illinois: Prairie near Chicago, Evanston, Lawn Ridge.
Missouri: Belleville.
Ohio: Kelley Island, Lake Erie.
New York: Garrison Creek, Sackett's Harbor, Lake Ontario.
Arkansas.
Virginia: Petersburg.
Mississippi: Monticello.
Louisiana: New Orleans.

27. C. Nebrascensis.
Nebraska.

28. C. latimanus.
Georgia: Athens.
South Carolina.

29. C. Mexicanus.
Mexico.

30. C. Cubensis.
Cuba.

31. C. advena.
Georgia.
South Carolina: Charleston.
Alabama: Mobile.

32. C. Carolinus.
Georgia.
Carolina (or South Carolina?).

Genus ASTACUS.

33 (1). A. Gambelii.
California.

34 (2). A. nigrescens.
California: San Francisco.

35 (3). A. Trowbridgii.
Oregon: Astoria.

36 (4). A. Klamathensis.
Oregon: Lake Klameth, Cascades.

A. Klamathensis — *Continued.*
British Columbia: all streams east of the Cascades.

37 (5). A. leniusculus.
Oregon: Columbia River.
Washington Territory: Puget Sound.

38 (6). A. Oreganus.
Oregon: Columbia River.

DISTRIBUTION OF THE SPECIES OF CAMBARUS

IN EVERY STATE OR TERRITORY ACCORDING TO LOCALITIES YET ASCERTAINED.

1. Maine. — None.

2. New Hampshire. — None.

3. Vermont. — *C. Bartonii*, Burlington, Shelburne, Colchester, Chittenden County, in affluents of Lake Champlain.

4. Massachusetts. — None. I am told by Mr. S. H. Scudder that fresh-water crabs (*C. Bartonii*) have been collected in the western parts, at Williamstown. Lewis R. Gibbes cites, on the authority of Dr. Gould, *C. Bartonii* from Massachusetts.

5. Connecticut. — None.

6. Rhode Island. — None.

7. New York. — Seven species: *C. acutus* var. B., *C. affinis*, *C. propinquus*, *C. obscurus*, *C. Bartonii*, *C. robustus*, *C. obesus*.

C. Bartonii lives in the western part of the State, on the Hudson River and its affluents; in the southern, at Newburg and Fishkill; in the northeastern, along Lake Champlain, and particularly at Elizabethtown, Essex County; also in the Tioga affluent of the Susquehanna at Berkshire, Tioga County. Rafinesque also mentions Lake George, Saratoga, Utica, and Oswego, but perhaps the latter locality belongs to *C. proprinquus*.

C. propinquus lives in the northern part of the State, in Lake Ontario, in its affluents, the Genesee River at Rochester, Garrison Creek near Oswego, Lake Oneida, Four-Mile Creek near Sackett's Harbor, and in Grass River, a branch of the St. Lawrence River.

C. obscurus and *C. robustus* also live in the Genesee River at Rochester, *C. obesus* lives in Garrison Creek.

C. affinis lives in the western part, at Niagara. For *C. acutus* the locality is not given.

Our knowledge of the great State of New York is mostly confined to the northern and the western border. The remainder, with the exception of a small portion of the southern limits, is unknown.

8. New Jersey. — Three species: *C. acutus* var. B., *C. affinis*, *C. Bartonii*. The first species is from Essex; of the second the locality is not given; the third is from Schooley's Mountain, Morris.

Of the State of New Jersey our knowledge is limited to two points in two counties very near New York, and to the rivers which empty into the outlet of the Hudson River.

9. Delaware. — None.

10. Pennsylvania. — Three species: *C. affinis*, *C. obscurus* (?), *C. Bartonii*.

The first and the third species are known from the Delaware River (Philadelphia) and from the Schuylkill River (Carlisle, Reading), from the Susquehanna and its affluents (Hummelstown, Berwick), and from the Ohio (Pittsburg). *C. obscurus* (if it be the *A. fossor* Raf.) is from Philadelphia.

In the great State of Pennsylvania, which consists of sixty-five counties, we are acquainted with only a few single localities in six counties. Of these, one is on the eastern border, another on the western, while the four others lie near together in the middle of the State.

11. Maryland. — One species: *C. affinis*.

Only one locality, Havre de Grace, at the mouth of the Susquehanna, is known.

12. Virginia. — Five species: *C. acutus*, *C. Bartonii*, *C. robustus*, *C. obesus*, and *C. obscurus* (if it is the *A. fossor* Raf.).

Out of one hundred and sixty-five counties our knowledge extends to only four, — the James River and its affluents, at Petersburg, the Rappahannock (Fredericksburg), and Greenbrier River in the western part.

13. District of Columbia. — One species: *C. Bartonii*, at Georgetown.

14. North Carolina. — Three species: *C. acutus* var. B., *C. Lecontei*, *C. immunis*; all from Beaufort, on the southeastern border.

15. South Carolina. — Seven species: *C. acutus*, *C. troglodytes*, *C. Blandingii*, *C. penicillatus*, *C. latimanus*, *C. advena*, *C. Carolinus*.

C. Blandingii is from the northern border, Wateree River; all the others are from Charleston and Summerville, on the southern border.

16. Georgia. — Ten species: *C. troglodytes*, *C. Lecontei*, *C. spiculifer*, *C. angustatus*, *C. maniculatus*, *C. penicillatus*, *C. extraneus*, *C. latimanus*, *C. advena*, *C. Carolinus*.

Georgia, thanks to the monograph of Mr. John LeConte, is as yet still the best explored State. He describes nine species; one, *C. fossarum*, is perhaps identical with *C. troglodytes*. *A. Blandingii* I have not been able to determine with certainty. Two other species have been seen by him, making in all ten species, exactly the number I have marked. It is a pity that he never gives the exact localities. *C. spiculifer*, *C. latimanus* are noticed as living "in Georgia superiore"; *C. troglodytes*, *C. fossarum*, *C. maniculatus*, *C. angustatus*, *C. advena*, "in Georgia inferiore"; *C. Blandingii*, "in regionibus intermediis."

Our knowledge of localities enables us to credit *C. spiculifer* and *C. latimanus* to Athens, *C. Lecontei* to Milledgeville, and *C. spiculifer* to Roswell; also to two points in the northern parts and to one in the middle of the State. *C. extraneus* is cited from the Tennessee River, Georgia, but this river does not touch the limits of Georgia.

17. Florida. — Two species: *C. fallax* and *C. Lecontei.*

The only locality given is Pensacola, on the northwestern border, near Alabama. Our knowledge of Florida also is very scanty. Lewis R. Gibbes quotes *C. affinis* from Florida, but his determinations are not at all trustworthy.

18. Alabama. — Five species: *C. acutus*, *C. Lecontei*, *C. versutus*, *C. immunis*, *C. advena.*

C. immunis lives in Huntsville, on the northern border; all the other species occur at Mobile, in the southwestern limits of the State. Nearly the whole State remains unexplored.

19. Mississippi. — Four species: *C. acutus*, *C. obesus*, *C. Lecontei*, *C. lucifer.* The first from the Mobile River, Kemper County, the middle of the eastern border of the State; *C. obesus* from Monticello; the two others from Root Pond, a locality unknown to me.

20. Louisiana. — Three species: *C. acutus*, *C. Clarkii*, *C. obesus.*

The species are from the southeastern border from New Orleans, one also from the northeastern border, from Milliken's Bend; all from the Mississippi. Nearly the whole State remains to be explored.

21. Tennessee. — One species: *C. placidus*, from Lebanon, nearly in the middle of the State.

22. Kentucky. — Three species: *C. pellucidus*, *C. juvenilis*, *C. Bartonii.*

Besides the celebrated species from the Mammoth Cave, *C. pellucidus*, the others are from Little Hickman and Hickman's Landing, near the Kentucky River, in the middle of the State.

23. Indiana. — Two species: *C. acutus*, *C. propinquus.*

Only one of the ninety-two counties gives a species; this is from Delphi, on the Wabash River, in the middle of the State.

24. Ohio. — Four species: *C. virilis*, *C. rusticus*, *C. Bartonii*, *C. obesus.*

Only in the southwestern part of the State, from Cincinnati and Columbia, and a little farther, from Dayton, Miami River, Montgomery County, are species noticed. *C. obesus* is from Kelley Island, Lake Erie. We know of species from only two of the eighty-eight counties.

25. Michigan. — None. I am told that fresh-water crabs occur in Lake St. Clair; species are also noticed from Lake Superior.

26. Wisconsin. — *C. virilis*, from the Sugar River. I am told that fresh-water crabs are found near Milwaukee.

27. Minnesota. — None. Professor Agassiz has found a species of *Cambarus* at Minnehaha Falls, above St. Paul. I have not seen the specimen.

28. Iowa. — One species: *C. virilis* is found in the Mississippi at Davenport and Burlington, along the southeastern border. The State is unexplored.

29. Illinois. — Seven species: *C. acutus* var. A., *C. troglodytes*, *C. virilis*, *C. placidus*, *C. propinquus*, *C. immunis*, *C. obesus.*

This State is one of the best explored, for I have seen in the Museum of the Chicago Academy sixty glasses with *Cambarus*, mostly from the different localities of Illinois, but I was not able to ascertain the species. There are known from the northern border, as at Chicago and Evanston, *C. acutus* var. A., and *C. obesus;* from the middle northern parts (Illinois River and affluents), Ogle County, Lawn Ridge, Basson Pudge, Peoria, Athens, *C. acutus* var. A., *C. troglodytes*, *C. propinquus*, *C. immunis*, *C. obesus*, and from the western border from the Mississippi, from Quincy and Belleville, *C. virilis*, *C. placidus*, and *C. immunis*.

30. Missouri. — Five species: *C. acutus*, *C. virilis*, *C. juvenilis*, *C. Bartonii*, *C. obesus*. All are from St. Louis and from the Osage River, near the centre of the State.

31. Arkansas. — One species: *C. obesus*, locality unknown.

32. Texas. — Three species: *C. Clarkii*, *C. virilis*, *C. placidus;* the first occurs near the middle of the State, between San Antonio and El Paso del Norte; of the others the localities are unknown.

33. Indian Territory. — None.

34. Kansas. — None. I have seen only one species in the Chicago Museum.

35. Nebraska. — One species: *C. Nebrascensis*, without locality.

36. Dakota. — None. I have seen only one specimen in the Chicago Museum.

37. Wyoming. — None.

38. Montana. — None.

39. Idaho. — None.

40. Colorado. — None.

41. Utah. — None.

42. Arizona. — None.

43. New Mexico. — None.

44. Nevada. — None.

45. Washington Territory. — One species: *A. leniusculus*, at Puget Sound.

46. Oregon. — Three species: *A. Trowbridgii*, *A. leniusculus*, *A. Klamathensis*. From Astoria, from the Columbia River and Lake Klamath. The locality of *A. Oreganus* is doubtful.

47. California. — Two species: *A. Gambelii* and *A. nigrescens*. From San Francisco.

British America. — Five species: *C. virilis*, *C. propinquus*, *C. Bartonii*, *C. robustus*, *C. Klamathensis*.

In Canada from the Humber River near Toronto is noticed *C. robustus*. In Lake Superior *C. Bartonii*, *C. propinquus*, *C. virilis* occur, the latter also in Lake Winnipeg, Saskatschavan, and the Red River. *A. Klamathensis* is found in British Columbia.

Mexico. — Two species: *C. Wiegmanni*, *C. Mexicanus*. One from the marshes of the valley of Mexico, the other without known locality.

Cuba. — One species: *C. Cubensis*, from the marshes in the central part of Cuba.

According to the list given above, we know nothing upon the geographical distribution or even the existence of species in the following nineteen States and Territories: —

1. Maine, New Hampshire, Massachusetts, Connecticut, Rhode Island, Delaware, Michigan, Minnesota, Indian Territory, Kansas, Dakota, Wyoming, Montana, Idaho, Colorado, Utah, Arizona, New Mexico, Nevada.

2. From nine States and Territories we know one species, the locality being definitely known in only one half of them, viz., Vermont, Maryland, District of Columbia, Tennessee, Iowa, Arkansas, Wisconsin, Nebraska, and Washington Territory.

3. From three States we know two species, viz., Florida, Indiana, California.

4. From eight States we know three species, viz., New Jersey, Pennsylvania, North Carolina, Louisiana, Kentucky, Texas, Oregon.

5. From Ohio and Mississippi, four species.

6. From three States we know five species, viz., Virginia, Alabama, Missouri.

7. From three States we know seven species, viz., New York, Illinois, South Carolina.

8. From one State we know ten species, viz., Georgia.

The first step to take, and the best way if we would make progress in knowledge, is always to ascertain how limited it is; and for this purpose it is evidently profitable to show that the undoubtedly unrivalled materials before me represent a very limited part of the gigantic territory comprised in the United States. Besides more than the western half, noticed before as not represented in our catalogue, it is surprising that the much-explored New England States are nearly wanting. Perhaps the multitude of manufactories and the consequent spoiling of the water, especially of the running streams, has some influence on the rarity of the fresh-water crabs; but a more careful exploration is doubtless necessary to prove the existence or the absence of *Astacidæ*.

At the same time some of the other States, seemingly better represented in our catalogue, are far from being well explored: even some, furnishing the largest number of species, are in reality to a great extent unexplored.

Of the great State of New York we are only acquainted with the eastern border, and in New Jersey with a single locality in the vicinity of New York City. In Maryland and the two Carolinas we know only a small area, along the eastern limits. In Florida, Alabama, and Louisiana, only the localities very near to each other are noticed, while all the rest of these States are unexplored. The number of species in

Georgia, the best explored portion of the country, suggests how much may be found in the adjacent States. The Middle States are in parts better explored, but without doubt they will furnish many new species or show a wider distribution of the known species, as is stated in our catalogue.

It would be very interesting to ascertain whether the extensive tablelands between the Sierra Nevada of California and the Rocky Mountains, as well as the great American desert, possess species of the genus *Astacus* or of the genus *Cambarus* or not. As yet nothing is known about these regions.

Perhaps under these circumstances a detailed exposition of the geographical distribution of the North American *Astacida* would be premature and incorrect, but some facts are too striking and too apparent to be overlooked, even at this stage of our knowledge.

The first and chief point ascertained as yet is the strict limitation of the genera *Astacus* and *Cambarus*, which completely exclude each other. In the parts west of the Sierra Nevada, and perhaps of the Rocky Mountains, lives the genus *Astacus*, in all the eastern parts the genus *Cambarus*. At present no exception is known. This fact is all the more interesting, as the only species known from the eastern parts of Asia, *Astacus Dauricus Pallas*, which is probably identical with *Astacus leptorhinus* Fisher, from the Amur River, seems to be a group intermediate between the European and North American species of *Astacus*, and more nearly related to the species of the latter country.

Our knowledge of the geographical distribution of the North American species of *Astacus* is as yet too limited for us to say anything more respecting them.

The second fact, which seems to be ascertained, is that the genus *Cambarus* is confined to the other parts of North America and perhaps to the Antilles. I have not seen the species described by Erichson and de Saussure from Cuba, but it doubtless belongs to the genus *Cambarus*. The asserted presence of the genus *Cambarus* in South America is to be discredited, unless further and more trustworthy evidence be produced in its favor. *C. Chilensis*, mentioned by Erichson as a species of *Cambarus*, was never seen by him, and seems from the description to be more nearly related to *Cherax*, or perhaps to represent some distinct genus. I have seen one and only one specimen of *Astacida* from Brazil, — if there be no error as to the habit, which was apparently the case with some *Astacus fluviatilis* communicated to me as Brazilian species, — a male in a very bad state of preservation, and evidently nearly related to *C. Chilensis*. As the specimen is dry and very old, it is impossible to ascertain whether it have gills or not on the fifth pair of legs.

The *C. Bartonii*, figured and described as perhaps from Brazil by Mr. Dana in his excellent work, is certainly not identical with the *C. Bar-*

tonii from North America. The habitat is uncertain, and so not of decisive value.*

Concerning the geographical distribution of the genus *Cambarus*, we find the interesting fact that the most distinct group, containing the species related to *C. acutus*, seems to be confined to a limited territory. Its boundaries answer for the most part to the Southern fauna, traced by Professor L. Agassiz for the *Chelonians*, but is somewhat more extensive, as some species are observed to live also in the upper parts of the rivers and their affluents. Beginning on the Atlantic coast in Virginia (also farther north, as with the *Chelonians*), it extends through the Carolinas, Georgia, Florida, Alabama, Mississippi, Louisiana, and Texas.

Some species follow up the Mississippi and its tributaries for a great distance, while a peculiar variety, described by me as *C. acutus* var. A, has its habitat far to the north, and is not to be found in the southern parts. It is very interesting to remark that the same species is to be found farther north on the Atlantic coast, forming also a peculiar variety, described by me as *C. acutus* var. B, from New Jersey and New York. It was impossible for me to give an adequate account of it, as I have not seen the male.

Our knowledge of the Mexican fauna is very meagre, but it seems probable that a few species at least belong to the same group. Still more interesting is the fact that some species of the other *Cambarus* groups, living within the limits noticed for the species for the first group, have an analogous appearance and shape of body, viz., *C. bucifer*, *C. immunis*, *C. extraneus*, *C. advena*, and *C. Carolinus*.

I have heretofore stated that these species, even when viewed under other relations, constitute aberrant forms. But it should be remembered that several species, viz., *C. placidus*, *C. obesus*, *C. latimanus*, which also live in the same southern country, belong in all their characters to very different groups. The groups of *Cambarus*, as defined by me, do not apparently coincide with certain faunal regions.

The species of the second group, except the aberrant forms before mentioned, especially the species related to *C. virilis*, belong to the northern and middle parts of North America. These species occur especially in the Northern Lakes and their affluents, also in the Missouri, Mississippi, Ohio, and their tributaries, and in Texas.

C. affinis, a somewhat peculiar species, alone lives in the rivers running eastward to the Atlantic coast, in the Hudson, Delaware, Potomac, Susquehanna, and their affluents.

* Von Martens, in Troschel Archiv, 1869, T. 35, p. 15 sqq., describes two species of fresh-water crabs from Brazil, *Astacus pilimanus*, p. 15, Tab. 2, fig. 1, from Porto Allegre and Santa Cruz, in the affluents of the Rio Pardo River, which is an affluent of the Jacuhy River, with burrowing habits, *Astacus Brasiliensis*, p. 16, Tab. 2, fig. 2, from Porto Alegre and from Roedersberg, in ponds and small rivers. The latter is perhaps the species from Brazil mentioned by me, p. 11.

Professor H. Burmeister writes to me that he has seen a species of *Astacus* from the Banda oriental.

Evidently the faunal area of the second group of species coincides with that of the first group in the vast regions watered by the Mississippi and its branches, without touching, except in some aberrant forms, the southeastern regions.

The third group occurs in the whole country inhabited by the two others, in the Northern Lakes and their affluents, in the rivers running both to the Atlantic coast and to the Mississippi; in short, equally in the northern and southern, in the eastern and western parts of the United States. *C. Bartonii* and the next allied species are to be found in Lake Superior and in the St. Lawrence River, in Nebraska, Arkansas, Louisiana, and along the Atlantic coast from Vermont to South Carolina, and perhaps to Florida.

An interesting fact in the geographical distribution of the animals is the association or exclusion of certain species, also the representation of given species in different localities by others that are closely allied.

Concerning the association of particular species, I would remark that the materials before me give for two localities four species. I have seen from Charleston, *C. acutus*, *C. troglodytes*, *C. penicillatus*, and *C. advena;* from Mobile, *C. acutus*, *C. Lecontei*, *C. versutus*, and *C. advena.*

From six localities three species are cited: from New Orleans, *C. acutus*, *C. Clarkii*, *C. obesus;* Lawn Ridge, *C. acutus*, *C. immunis*, *C. obesus;* Beaufort, *C. acutus*, *C. Lecontei*, *C. immunis;* Lake Superior, *C. virilis*, *C. propinquus*, *C. Bartonii;* Rochester, *C. propinquus*, *C. obscurus*, *C. robustus;* Osage River, *C. virilis*, *C. juvenilis*, *C. Bartonii.*

Two species are quoted from more localities: from St. Louis, *C. acutus*, *C. obesus;* Root Pond, *C. Lecontei*, *C. lancifer;* Athens, Ga., *C. spiculifer*, *C. latimanus;* Quincy, Ill., *C. virilis*, *C. placidus;* Niagara, *C. affinis*, *C. propinquus;* Philadelphia, *C. affinis*, *C. Bartonii;* the Mammoth Cave, *C. pellucidus*, *C. Bartonii;* Cincinnati, *C. rusticus*, *C. Bartonii;* Evanston, Ill., *C. acutus*, *C. obesus.*

The list given shows no regularity, at least I am not able to find any; still, this is perhaps because of the incompleteness of the material. Looking over the species that occur together, we find the most nearly related living with those that are evidently different; those of the first group with others of the second, some of the second with others of the third, and even all three groups in the same locality.

No more regularity is to be found in association of the different species. *C. acutus* lives in seven different localities together with eight different species, the half belonging to the other groups. *C. advena* is found in the same localities with five other species, none belonging to its own group. *C. Lecontei*, *C. obesus*, *C. virilis*, *C. Bartonii* live together with four, *C. propinquus* with five different species, partly belonging to different groups.

The uncertainty already referred to prevents my dwelling upon the

exclusion or representation of particular species. New explorations would no doubt very soon and perhaps entirely alter any views we might form from incomplete materials.

C. acutus, *C. virilis*, *C. Bartonii*, and *C. obesus* are the most widely spread species.

The geographical distribution according to the river systems is as follows: —

The rivers west of the Mississippi, running to the Gulf of Mexico, are little explored. From Texas, perhaps from the branches of the Colorado, *C. Clarkii*, *C. virilis*, and *C. placidus* are cited; the two latter were collected by Mr. Stolley, the locality not being given.

The Mississippi and its numerous well-known affluents contain a great number of species. In the lower part of this river, and in its inferior affluents, especially near its mouth, as at New Orleans, occur *C. acutus*, *C. Clarkii*, *C. obesus;* a little higher up in the branches on either side are found *C. Clarkii*, *C. Lecontei*, *C. lancifer*, *C. obesus*.

The Ohio River and its affluents furnish *C. virilis*, *C. placidus*, *C. juvenilis*, *C. rusticus*, *C. Bartonii;* while in the Wabash River, one of its lower branches, occur *C. acutus* and *C. propinquus*. The fauna of the Ohio River is also quite different from that of the Lower Mississippi, if we exclude from consideration *C. acutus* and the two species *C. virilis* and *C. placidus*, which are found in the Colorado River.

The middle part of the Mississippi, the Missouri, with the Osage River and their several branches, contain *C. acutus*, *C. obesus*, *C. Nebrascensis*, *C. placidus*, *C. virilis*, *C. juvenilis*, *C. Bartonii;* the three latter species being from the Osage River; also nearly the same species as are cited in the Ohio fauna.

In the Upper Mississippi and its affluents, especially in the Illinois River, are found *C. acutus* var. A., *C. troglodytes*, *C. virilis*, *C. placidus*, *C. propinquus*, *C. immunis*, *C. obesus*. It is worthy of remark that a channel unites the Illinois and the Chicago Rivers, and that perhaps in this way may be explained the occurrence of the southern species *C. acutus* and *C. obesus* at Evanston, on Lake Michigan. Among the several rivers and their branches lying to the east of the Mississippi, it may be added that the Mobile River contains *C. Clarkii*, *C. Lecontei*, *C. versutus*, *C. immunis;* while in the Florida rivers occur *C. Lecontei* and *C. fallax*. Two of them, *C. versutus* and *C. fallax*, are not as yet known farther to the west.

The rivers east of the Alleghany Mountains furnish in Georgia, *C. troglodytes*, *C. Lecontei*, *C. spiculifer*, *C. angustatus*, *C. maniculatus*, *C. penicillatus*, *C. extraneus*, *C. latimanus*, *C. advena*, *C. Carolinus;* also besides the first two a quite different and new fauna. Farther north, in South Carolina, live *C. acutus*, *C. troglodytes*, *C. Blandingii*, and *C. penicillatus;* in North Carolina, *C. acutus*, *C. Lecontei*, and *C. immunis*, — species which

are nearly all, except *C. Blandingii* and the Georgian *C. penicillatus*, represented at the mouth of the Mississippi.

In Virginia, in the James River and its affluents, we find *C. Bartonii* and *C. robustus*, with the southern form *C. acutus*. The first-named species descends no farther than to the middle of the Mississippi; the second is of a decidedly northeastern type, more properly belonging to the fauna characteristic of the waters that empty into the St. Lawrence. In the more northern rivers, especially in the Potomac, Susquehanna, Delaware, and their tributaries, we find *C. Bartonii* and *C. affinis*, and perhaps *C. obscurus*.

In the Hudson River, also in the other streams as far north as Vermont, and in Lake Champlain, occurs *C. Bartonii*. But the mouth of the Hudson River in New Jersey and New York is the extreme limit of a peculiar variety of the southern species *C. acutus*, which is well represented in North Carolina.

The fauna east of the Alleghany Mountains is also very peculiar. Perhaps the most peculiar part is the well-explored and striking fauna of Georgia. But we find farther to the north — besides *C. acutus*, widely extended in the South, and *C. Bartonii*, a species to be found in the whole middle part of the United States, — the exclusively northeastern species *C. affinis* and *C. obscurus*.

The northern fauna, comprised in the immense water-basin of the St. Lawrence and its tributaries, furnishes in Lake Superior, *C. virilis*, *C. propinquus*, *C. rusticus*, *C. Bartonii;* in the Niagara, *C. affinis* and *C. propinquus;* in Lake Ontario and its affluents, especially Genesee River and Lake Oneida, *C. propinquus*, *C. obscurus*, *C. Bartonii*, *C. robustus*, *C. obesus*. Some of these species, and in fact all those found in Lake Superior, as *C. virilis*, *C. propinquus*, *C. rusticus*, *C. Bartonii*, *C. obesus*, are also represented in the regions watered by the Upper Mississippi and its branches; *C. obscurus*, *C. affinis*, and *C. robustus* are the only species peculiar to the northern fauna. The remarkable habitat of *C. acutus* and *C. obesus* in Lake Michigan has been before mentioned.

C. virilis occurs in the more northern waters, which empty into Hudson's Bay, especially in Lake Winnipeg, Saskatschavan, and Red River. I am told that these waters are connected in the summer time through marshes with the affluents of the Upper Mississippi.

We also find true, especially for the genus *Cambarus*, that the United States are divided into three great faunal regions, — the region traversed by the Mississippi; the eastern region, lying between the Alleghany Mountains and the Atlantic coast; and the northern region, which is watered by the Northern Lakes and the St. Lawrence. I have not spoken of the Mexican and Cuban species, my acquaintance with them being as yet very imperfect.

The three great regions just mentioned, particularly the first and the

second, doubtless comprise several subordinate faunal districts. The region watered by the Mississippi apparently divides itself into two parts, a southern and a northern, the latter beginning near the mouth of the Ohio River. The eastern region has a decided and peculiar southern fauna, which is perhaps to be united with that of Cuba, and a northern fauna beginning in Pennsylvania. In the northern region there seems hardly any difference between the eastern and western parts. Nevertheless, it is certain that some species belong to more than one region, and that these regions do not coincide with the three principal groups of the genus *Cambarus*. The first group, as has been already stated, prevails in the southern parts of the western and eastern faunal region; the second group prevails partly in the northern part of the eastern faunal region.

The examination of the distribution of single species, or rather the exact determination of the circle in which every species lives and the central point which is to be taken as its most proper habitat, would be very interesting, if the materials at command were sufficiently abundant. The greatest impediment to such an examination is the scantiness of our knowledge, I may say our almost entire ignorance, of the great country comprising the Alleghany Mountains and circumjacent regions.

A detailed examination of the questions suggested being as yet impossible, I may be permitted to offer a few words upon some of the most widely spread species.

The central point of *C. acutus* seems to be the southern shore around the mouth of the Mississippi; of *C. affinis*, the Lower Potomac; of *C. virilis*, Lake Superior; of *C. propinquus*, Lake Ontario; of *C. obesus*, the middle part of the Mississippi; of *C. Bartonii*, perhaps the middle of the eastern part of the United States. Some of these so-called central points are in fact not at all central, they being either near the shore of the sea or not far from the limits, so far as we yet know, of the distribution of the species. I accordingly attach no great value to them, as they are liable very soon to be greatly modified by new explorations.

The number of species now known to belong to the old genus *Astacus* is 56. Of these there are in America, 40 (two in South America): New Holland, 11; Asia, 2; Europe, 2; Africa, 1.

As now distributed, there belong to the genus *Cambarus*, 32; *Astacus*, 13; (Astacoides) *Astacoides*, 4; *Cherax*, 1; *Engaus*, 2. The systematic position of the other species is not yet ascertained.

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New Eng Lith Co Boston

New Eng Lith Co Boston

New Eng Lith Co. Boston.

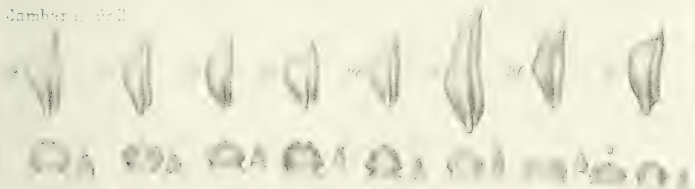
Cambarus Gr I

Clarkii. acutus. acutus var B. Lecontei. angustatus.

Cambarus Gr. II

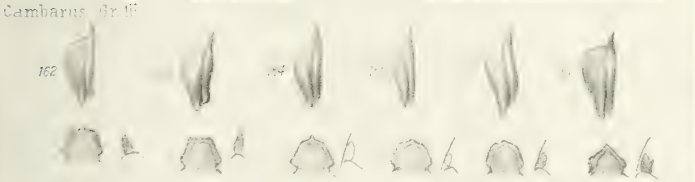
spiculifer. pellucidus. penicillatus. versutus. Virginiana. affinis. propinquus.

Cambarus Gr. I



Bartonii. virilis. extraneus. juvenilis. placidus. lancifer. immunis. rusticus.

Cambarus Gr. III



latimanus. obscus. advena. Carolinus. Bartonii. robustus.

Astacus.

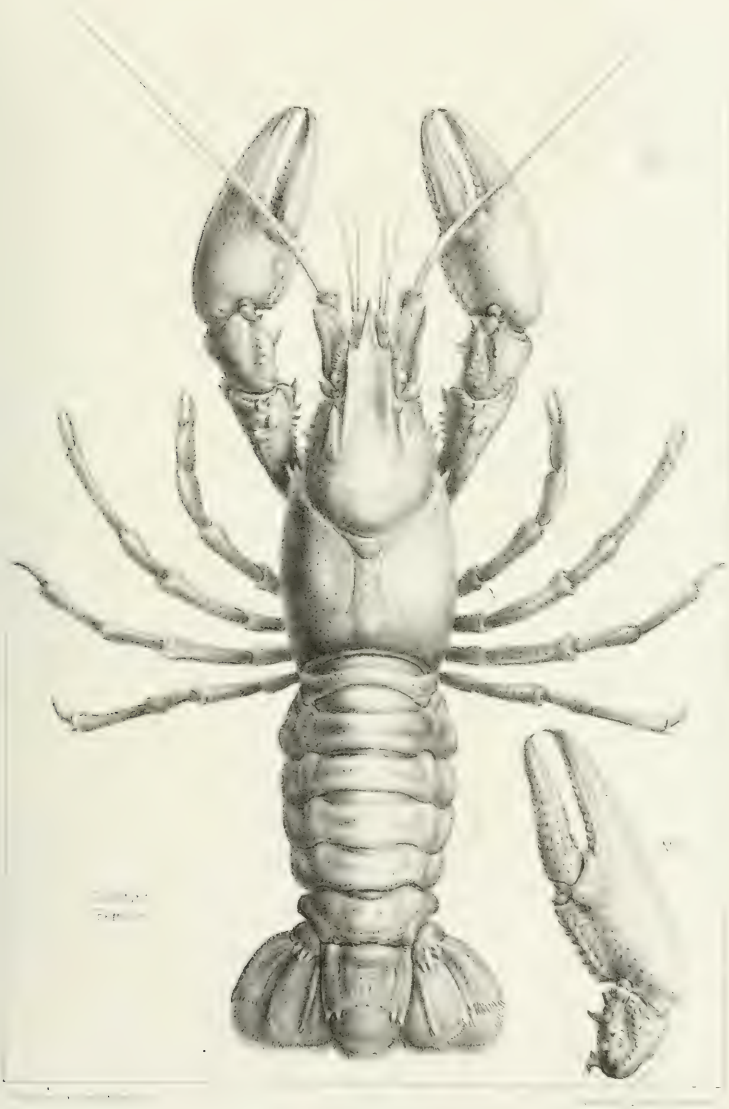
a. lamina antenn
b. epistoma.
c. spina externa artic 2 antenn

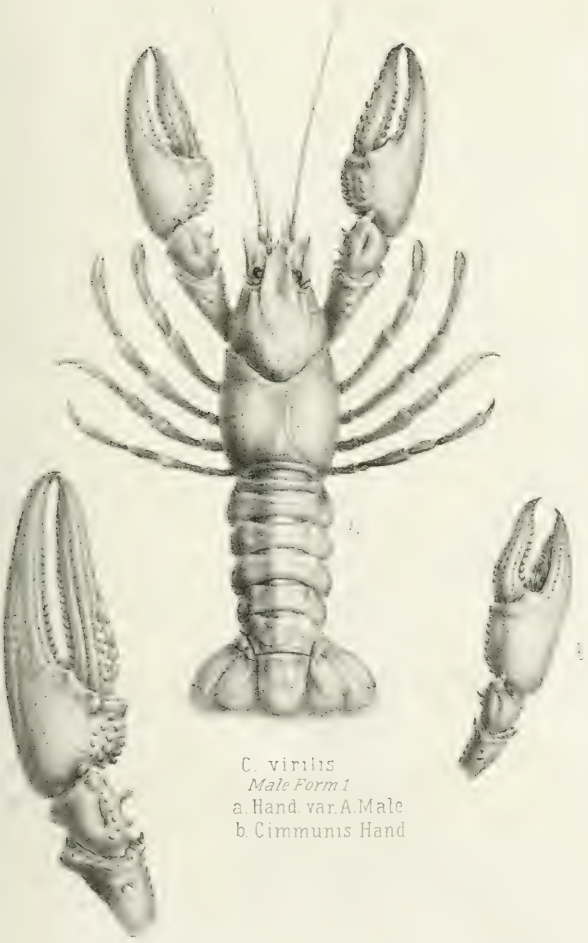
mexicanus. pubescens. Bartonii. Gambelii. Trowbridgii.

J. Eaton del. P. Bostler on stone. New Eng. Lith. Co. Boston.

F Roetter on stone from nat

New Engl Lith Co Boston



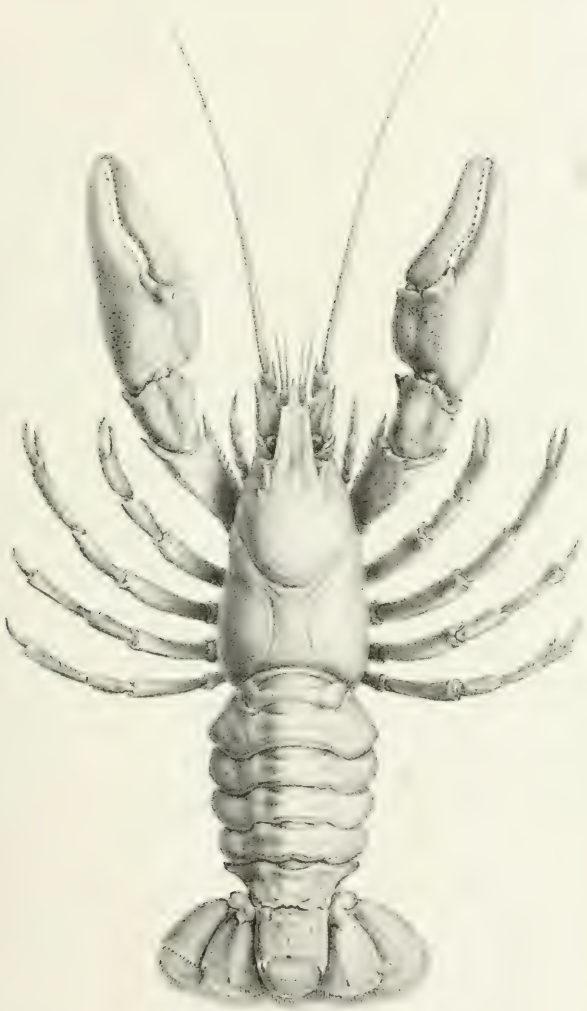


C. virilis
Male Form 1
a. Hand. var. A. Male
b. Cimmunis Hand

P. Roetter on stone from nat.

New Eng. Lith. Co. Boston

New Eng Lith Co Bost



P. Roetter, on stone from nat.

New Eng. Lith. Co. Boston

A. Gambelii. Male

F. Roetter, on stone from nat

New Eng. Lith Co Boston

ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. IV.

DEEP-SEA CORALS.

BY

L. F. DE POURTALÈS.

ASSISTANT U. S. COAST SURVEY.

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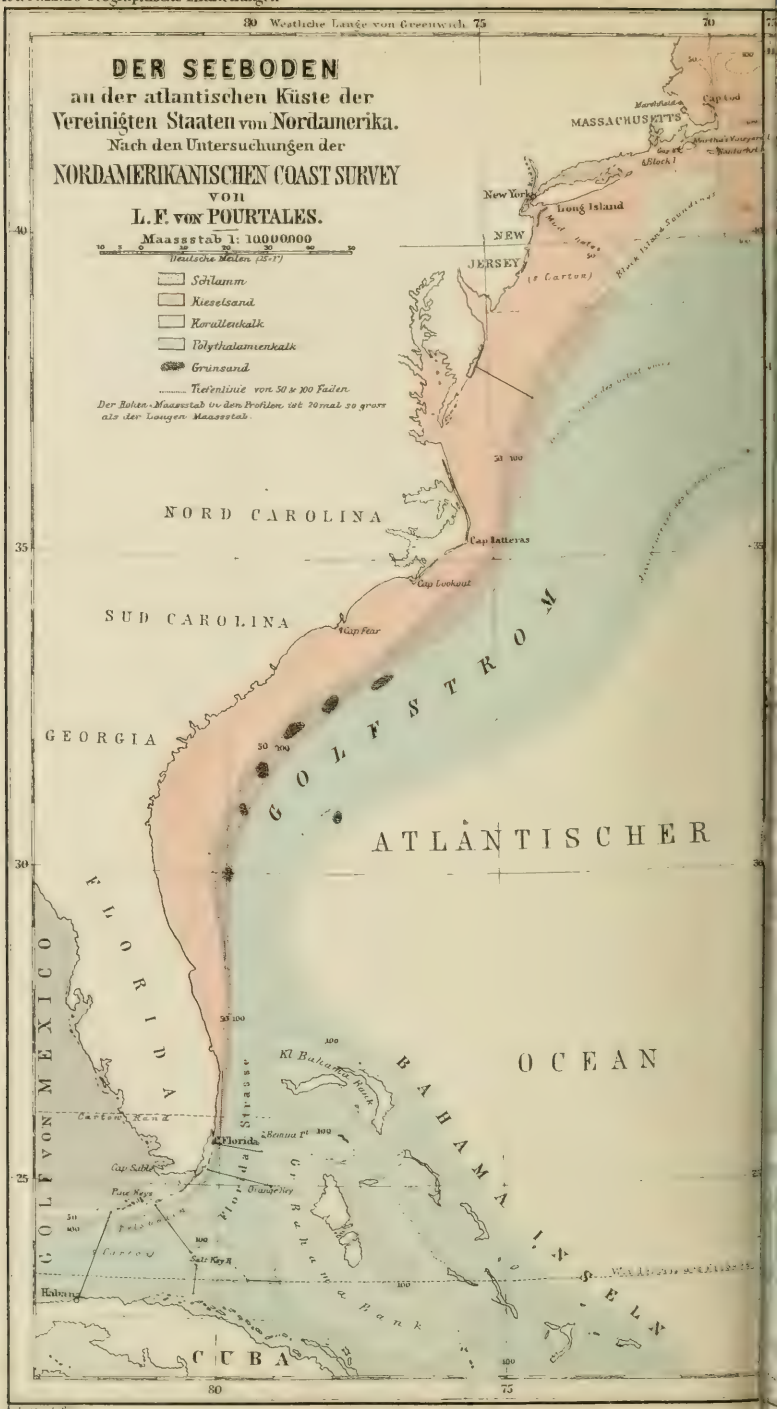
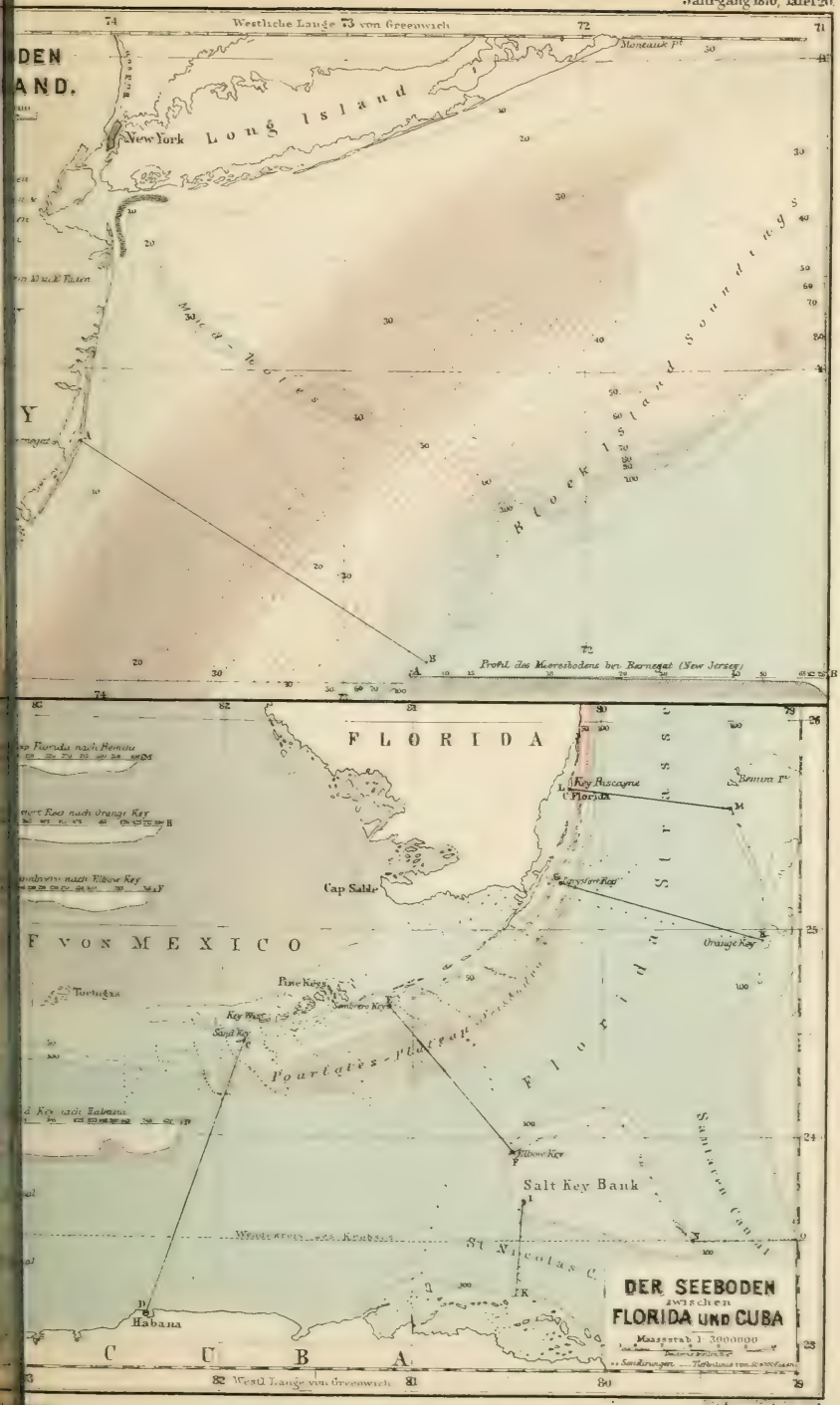

DER SEEBODEN
an der atlantischen Küste der
Vereinigten Staaten von Nordamerika.
Nach den Untersuchungen der
NORDAMERIKANISCHEN COAST SURVEY
VON
L. F. von POURTALES.
Maassstab 1: 10000000
Deutsche Meilen (15 = 1°)
Schlamm
Kieselsand
Korallenkalk
Polythalamienkalk
Grünsand
Tiefenlinie von 50 zu 100 Faden.
Der Höhen-Maassstab in den Profilen ist 70mal so gross als der Längen-Maassstab.
80 Westliche Länge von Greenwich 75
70
40
35
30
25
MASSACHUSETTS
Cap Cod
New York
Long Island
NEW
JERSEY
NORD CAROLINA
Cap Hatteras
Cap Lookout
SUD CAROLINA
Cap Fear
GEORGIA
GOLFSTROM
ATLANTISCHER
OCEAN
GOLF VON MEXICO
FLORIDA
Florida
Cap Sable
Florida Strasse
Bahama Bank
Kl. Bahama Bank
Carysfort Reef
Key West
Cap Florida
Rebecca Shoal
Tortugas
Salt Key R.
Havana
CUBA
BAHAMA ISLANDS


Westliche Länge 73 von Greenwich
New York
Long Island
Block Island Sound
Profil des Meeresbodens bei Barnegat (New Jersey)
FLORIDA
Cap Sable
Key Biscayne
Florida
Bimini I.
Orange Key
Florida Strasse
Pine Keys
Key West
Sand Key
Tortugas
Pourtales-Plateau
Elbow Key
Salt Key Bank
Havanna Canal
St Nicolas C.
Habana
C U B A
DER SEEBODEN
zwischen
FLORIDA UND CUBA
Maassstab 1 3000000
82 West Länge von Greenwich

ERRATA.

Page 50, line 12, *for* Parasmilia prolifera *read* Ceratocyathus prolifer.
" after line 37, *add* Lepidopora cochleata .... 270 C.

INTRODUCTION.

THE deep-sea corals described in these pages were collected in the years 1867, 1868, and 1869, during the expeditions made for the exploration of the Gulf Stream by the United States Coast Survey, B. Peirce, Superintendent, in the steamers Corwin and Bibb, Acting-Master Robert Platt, U. S. N., commanding.

It will not be superfluous to preface their description by a condensed statement of the successive steps taken by the Coast Survey in deep-sea researches, and by a short review of our present knowledge of the constitution of the bottom of the sea on the Atlantic coast of the United States. The subject has been already treated in a paper published by me in Petermann's *Geographishe Mittheilungen*, but it may be well to repeat it here for the benefit of English readers.

The first step of the investigation may be said to have been taken by the late Professor A. D. Bache, on his assuming the duties of superintendent of the United States Coast Survey in 1844, when he ordered the preservation of the specimens brought up by the lead during the progress of the hydrographical operations. The object was twofold, — a practical one, to check the indications of the character of bottom laid down on the charts by the hydrographers; and a scientific one, the formation of a collection illustrating the character of the bottom and the distribution of the materials constituting it along our coast.

The greater number of the specimens were obtained at first inside of the hundred-fathom line, but the deeper waters of the Gulf Stream soon began to add collections of still greater interest, if of less extent. Simple contrivances were substituted for the usual tallow arming the lead, so as to bring up the sand or mud in sufficient and uncontaminated quantities. Every specimen is placed in a small bottle, labelled with the date, geographical position, and depth, and preserved in cabinets arranged for the purpose in the Coast Survey Office in Washington.

The microscopical examination of the collection was begun by the late Professor J. W. Bailey, of the Military Academy at West Point, and after his death by myself, in the intervals of other duties.

The general results are exhibited on the map accompanying the paper in the *Geographische Mittheilungen*, and representing the bottom off our coast, from Cape Cod to the island of Cuba. The bottom is represented of different colors, according to its principal constituents, which are chiefly of four different kinds, — silicious sand, clay (the "mud" or "ooze" of the charts), Globigerina mud, and coral sand or mud. The silicious sand and the Globigerina mud have the greatest extent.

Silicious sand is, with few exceptions, the prevailing material from the shore to the hundred-fathoms line. It extends thus, skirting the shore in a broad band narrowing down to a point as far south as Cape Florida, where it ceases altogether, and is replaced by the coral formation, but reappears again on the west coast of the peninsula near Cape Sable.

Clay or mud occurs to a considerable extent only to the southward of the Vineyard Islands and eastern part of Long Island, in a region known to navigators as the Block Island Soundings, and also in a series of depressions off the entrance to New York, called the *Mud-Holes*. This mud, of a stiff consistency and dark gray color (called blue or green by the sailors), may be derived from the tertiary formations of which the bluffs off Gay Head, on the island of Martha's Vineyard, are the remainder.

Outside of the hundred-fathom line we find the Globigerina mud forming the bottom of the Gulf Stream, whose western edge coincides nearly with that line of depth, and of the greater part of the ocean, of the Gulf of Mexico, and of the deep channels separating the Bahama Banks from each other and from the neighboring lands. The discovery of this important formation is generally attributed to the expedition sent out under the command of Lieutenant Berryman, U. S. N., to sound out the path of the Atlantic Telegraph Cable in 1855. In reality, however, the discovery was two years earlier, Lieutenants Craven and Maffit, U. S. N., having severally, whilst engaged in Gulf Stream explorations, in the service of the Coast Survey, obtained specimens of this formation. (See Proceed. Americ. Assoc. for Advanc. of Science, Cleveland meeting, 1853.)

An interesting discovery was made by Professor Bailey in examining these specimens, — the transformation of Foraminifera into green-sand. The origin of the green-sand grains in geological formations had previously been recognized by Ehrenberg; but here we have evidently the process going on at the present day, particularly along a tract at the meeting of the silicious and Globigerina bottoms off the coast of Georgia and South Carolina, and also to a less extent in other places. (The localities are indicated by black dotting on the map quoted; near the mouth of New York Bay the same sign indicates tertiary green-sand, the continuation of the New Jersey beds.)

The specimens obtained by the lead did not suffice to give a true idea of the deep-sea fauna. The Foraminifera alone were numerous enough to give an idea of their distribution, which is approximately attempted by different signs and colors on subdivision B of the same map, representing the approaches to New York.

To extend our knowledge, therefore, Professor B. Peirce, when he assumed the superintendence of the Coast Survey, after the death of Professor Bache, ordered, at the instigation of Professor Agassiz, a more thorough exploration by means of the dredge.* A beginning was made in 1867, and the work continued during part of the working seasons of 1868 and 1869.

The ground explored is the part of the course of the Gulf Stream known as the Straits of Florida. (See map, Plate VIII.) Through these the stream passes from the Gulf of Mexico into the Atlantic Ocean. They run at first from west to east between the coast of Cuba and the Florida Reef and Keys, then bend in a semicircular sweep, to take afterwards a course nearly due north. On the outside of the bend, the old Bahama Channel opens into the straits through its two mouths, the St. Nicholas Channel and the Santaren Channel, separated from each other by the Salt Key Bank. In the part of the channel running due north, it is bounded by the Bahama Banks on the east and the Florida Reef on the west.

In transverse sections of the channel the greatest depth is nearest its southern or eastern shore, and in a longitudinal section the depth diminishes in passing towards the north, finding its minimum in the narrowest part between Cape Florida and the Bemini Islands, after which it increases again. In a transverse section between Key West and Havana, the greatest depth is 853 fathoms; between Sombrero Light and Elbow or Double-Headed Shot Key, on the Salt Key Bank, 500 fathoms; between Carysfort Reef and Orange Key, on the Great Bahama Bank, 475 fathoms; and between Cape Florida and the Bemini Islands, 370 fathoms.

* I cannot resist the temptation to add a short historical note on that important instrument of the modern naturalist, — the dredge. The Museum of Comparative Zoölogy possesses in its library, among the books formerly belonging to Professor de Koningk, the copy of O. F. Müller's Zoologia Danica, used by Tilesius in the voyage of circumnavigation of Captain Krusenstern in the beginning of this century. Tilesius, among many interesting remarks written on the fly-leaf, mentions the dredge invented and used by Müller, and represented in the vignette of the title-page; he purchased it on his passage at Copenhagen, in 1803, from Vahl, Müller's collaborator, and used it now and then during the voyage, though, as he admits, not often, as it took several sailors to handle it, the rope alone weighing eighty pounds! The expedition must have been decidedly short and weak-handed. On their return the dredge was deposited in the collection of the Imperial Academy of Sciences of St. Petersburg.

To O. F. Müller belongs the honor of having invented the dredge, very nearly in its more modern form, and of having inaugurated its use by naturalists in a most successful manner. His quaint remarks on the hopes and disappointments of the dredger, in the Preface of the Zoologia Danica, are worth reading.

In following a cross section from the emerged coral reef called the Florida Keys, the so-called Hawk Channel is first crossed, limited outside by the living coral reef. Its greatest depth is seldom more than six or seven fathoms, generally much less towards its northern extremity; it is often interrupted by shoals and so-called *heads* of live coral, and its bottom consists of calcareous mud from decomposed corals and corallines. Next comes the reef, rising nearly to low-water mark, but by no means continuous. It extends from Cape Florida south and west to a short distance beyond Key West, and seems to be slowly increasing in that direction.

Although the deep blue color of the water after passing the reef seems to indicate a very abrupt slope, there is in no part of it anything to compare with the sudden deepening on the edge of the coral reefs of the Pacific Ocean, or even of the Bahamas or the coast of Cuba. The distance from the reef to the hundred-fathom line is not less than three miles, and often as much as six. In this space the bottom consists of calcareous mud, and is not particularly rich in animal life.

From ninety or a hundred fathoms to two hundred and fifty or three hundred, the bottom slopes rather gently in the shape of a rough rocky floor, without great inequalities; this formation obtains its greatest breadth, of about eighteen miles, a little to the east of Sombrero Light, and tapers off to the west, where it ends in about the same longitude as the end of the reef; towards the east and north it approaches nearer the reef, and ends gradually between Carysfort Reef and Cape Florida. This bottom, which is called "Pourtales' Plateau," in Professor Agassiz's report, is very rich in deep-sea corals, the greater number of those described in these pages having been dredged on this ground.

Outside of the rocky bottom the Globigerina mud prevails and fills the trough of the channel.*

On the Cuba shore the bottom is rocky and the slope very abrupt, particularly for the first four or five hundred fathoms. Along the Salt Key and Bahama Banks, the slope is also exceedingly abrupt, but the underlying rock is often covered with mud.

Each of these regions named has its peculiar coral fauna, as will be shown afterwards.

The dredgings began with a few casts in 1867 off Sand Key, Florida, and off Chorrera, a small harbor three or four miles west of Havana, the landing-point of one of the Florida and Cuba telegraph cables. The next year lines of soundings and dredgings were run across the St. Nicholas and Santaren Channels, from the Salt Key Bank to

* See Bulletin of the Museum of Comparative Zoölogy, Nos. 6, 7, and 13; also Petermann's Geog. Mittheilungen, 1870, Heft XI.

Sombrero Light, and on four different lines normal to the reef between Sombrero Light and Sand Key, and extending from the shore across the different kinds of bottom.

In 1869 a few casts were obtained on the Cuba coast and near the Salt Key Bank, and lines of soundings and dredgings ran to the westward of Tortugas, and at intervals of about ten miles between these islands and Sand Key, and between Sombrero and Cape Florida.* The localities of the dredgings are indicated on the map by small crosses.

As an appendix, I have added a preliminary list of the shoal-water and reef corals of Florida; a fuller account of them will be given by Professor L. Agassiz.

In the classification used, the system of Milne-Edwards and Haime has been followed generally; some of their subfamilies, however, I have thought proper to elevate to the rank of families and to separate altogether from their former associations. The affinities of the families to each other cannot be expressed by the order of arrangement in which they are placed, as a family or group may form the connecting link between more than two others. The larger groups are still more difficult to limit than the families, and have not heretofore been happily formed; as an instance, I would mention the association of the Eupsammidæ with the Madreporidæ, based only on the porous condition of the cœnenchyma, whilst the polyps of the two groups are entirely different from each other.

As long as we are confined to the knowledge of the hard parts of the corals, their classification must remain incomplete. For a full study of the soft parts a long residence on the spot is indispensable, as the investigation requires much time and patience. Much confusion has been introduced by a hasty examination of imperfectly expanded polyps, in which the shape and arrangement of the tentacles, of the mouth and the folds surrounding it, etc. is often exceedingly different from their condition in a well-developed, healthy animal.

I must express my thanks for aid received, in the shape of specimens for comparison, or the gift of publications not readily accessible, to Professor P. M. Duncan of King's College, Mr. W. S. Kent of the British Museum, Mr. J. G. Jeffreys of London, Professor A. E. Reuss of Vienna, Professor A. E. Verrill of Yale College, and lastly and principally to Professor Louis Agassiz, the instigator of these researches, the companion during part of the cruise of 1869, and the kind and obliging friend and adviser.

* The succession of the reefs or keys which may be mentioned in the descriptions of the corals are from west to east: Tortugas, Rebecca Channel, Quicksands, Marquesas, Boca Grande, Sand Key, Samboes, American Shoal, Bahia Honda, Sombrero, Coffin's Patches, Tennessee Reef, Alligator Reef, Conch Reef, French Reef, Carysfort Reef, Pacific Reef.

DEEP-SEA CORALS.

Family TURBINOLIDÆ M.-Edw. & H.

Caryophyllidæ Dana (pars).
Caryophyllidæ Verrill.

With some exceptions the family of Turbinolidæ, as defined by Milne-Edwards and Haime, seems to form a good natural group. The name is unfortunately chosen from one of the most aberrant genera composing it; but it is not a sufficient reason for changing it, as long as the genus Turbinolia and a few allied ones remain in the family.

The subdivision of the family into subfamilies (Caryophyllinæ and Turbinolinæ) characterized by the presence or absence of pali is not natural, genera nearly allied being thus separated from each other, and associated with very dissimilar ones. It would be better to make several groups of equal value, gathered around the genera Caryophyllia, Turbinolia, Desmophyllum respectively, and perhaps a part of the Parasmilidæ.

CARYOPHYLLIA Stokes.

Caryophyllia Ch. Stokes. Zoöl. Journ., t. III. p. 481, 1828.
Cyathina Ehrbg., Dana, M.-Edw., & H.
Caryophyllia M.-Edw. & H. Hist. Nat. des Corall.

Caryophyllia formosa Pourt.

Caryophyllia formosa Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate I., fig. 16.

More or less turbinate, on a rather slender curved or straight stem. Costæ equal, distinct only near the calicle; the latter circular or subovate, moderately deep. Columella formed of four to six twisted,

rather loose laminæ. Septa in six complete systems and four cycles, thin, prominent, sharp, and rounded on the edge, sparsely granulated. Twelve pali, equal, large, flexuous, with few and comparatively large granules.

The young are elongated, and show much diversity in their development as regards the columella and pali; when the columella is developed early, the pali are much delayed in their appearance, and *vice versa*.

The differences between this species and *C. cyathus* are not very striking; our specimens are, however, always smaller, slenderer, and have the columella much less developed.

None of my specimens attain the size of a full-grown Mediterranean specimen.

Off Havana in 270 fathoms.
Off Tortugas in 60 to 68 fathoms.

Caryophyllia Berteriana ? Duchass.

Caryophyllia Berteriana Duchassaing. Anim. rad. des Antilles, 1850.

A single specimen obtained in 68 fathoms off Tortugas, with the preceding species, differs from it and from *C. formosa* by its very prominent primary and secondary septa, thus resembling the figure of Milne-Edwards and Haime. The systems of septa are, however, all complete and very regular, so that there are twelve pali, as in all other Caryophylliæ. The descriptions of Duchassaing and Milne-Edwards and Haime appear to have been made from the same specimen, perhaps an exceptional one.

Caryophyllia clavus Scacchi.

Caryophyllia clavus Scacchi. Notiz. int. alle conch. ed. a zoof. foss., etc, 1835.
Cyathina turbinata Philippi. Enum. Moll. Sic. 1836.
Caryophyllia pseudoturbinolia Micii. Icon. Zooph. 1841.
Cyathina cyathus Leuckart. De Zooph. corall., 1841.
Cyathina pseudoturbinolia M.-Edw. & Haime. Ann Sci. Nat., 3d Ser., t. XX., 1848.

I have selected, from the numerous authors who have mentioned this coral, those who have given figures representing the type approaching nearest my specimen. Not having the materials at hand to enable me to pronounce an opinion on Dr. Duncan's sweeping reduction of all the European species to a single one, and not wishing

to burden the nomenclature with a new name, I refer to *C. clavus* a number of specimens obtained near Tortugas, and also a few found with *C. formosa* on the coast of Cuba.

The passage from one form to the other is not plainly marked, though a good deal of variety certainly exists. On the Florida side not a single specimen of the *C. formosa* was found.

Caryophyllia cornuformis Pourt.

Caryophyllia cornuformis Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate I., figs. 14 and 15.

Corallum simple, conical, always regularly curved, distinctly but faintly costate. Calicle circular, rather shallow. Septa very little exsert, thin, and somewhat wavy, in six systems and four cycles. Pali in front of secondary septa only, sometimes twisted. Columella of one or two twisted processes. Height about 6 mm., diameter of calicle 3 mm.

Off Sand Key in 237, 248, and 298 fathoms.
Off Cojima, Cuba, in 450 fathoms.

All the specimens have the base broken and apparently decayed even when living, and were never seen attached. A specimen still living was agglutinated to the shell of a Xenophorus.

I was at first tempted to refer this species to the genus Ceratocyathus of Seguenza (an inconvenient name, by the way, very apt to be confounded with Ceratotrochus), but I have seen good reasons lately to remove altogether Seguenza's genus from the Caryophyllidæ and place it next to Parasmilia (which see).

STENOCYATHUS Pourt.

Corallum simple, free, very elongated, and of nearly equal diameter throughout; a single crown of pali; a columella of one or more twisted processes; no epitheca.

The single species known of this genus was placed by me in the genus Cænocyathus, having supposed the few specimens then in hand to be detached from clusters formed by budding. A larger supply has proved that they are always free.

Stenocyathus vermiformis Pourt.

Cœnocyathus vermiformis, Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate I., figs. 1 and 2; Plate III., figs. 11, 12, and 13.

Corallum very elongated, cylindrical. Costæ indicated only by lines of very flat tubercles. Calicle circular, shallow. Septa rather thick, flexuose, not exsert, in six systems of three cycles. Pali thick, curled, in front of the secondary septa. Frequently one of the systems remains incomplete, and there are then but five pali. Columella of a single twisted process. The older parts of the corallum are nearly filled up by the thickening of the septa, but the process is never carried out to a total obliteration of the interseptal chambers, which can be traced in the shape of slender canals to the very base.

The costal tubercles are hollow, and communicate through narrow canals with the interseptal chambers. These little cavities are no doubt homologous to the hollow roots of Rhizotrochus, Thecocyathus, and other genera of the family, but here their use is not apparent. (See Plate III., fig. 13, representing part of a horizontal section passing through these cavities.)

A singularity is the frequent occurrence of specimens having a living and growing polyp at either end (Plate III., fig. 11). These specimens are generally somewhat curved, having apparently been lying in the mud with both ends turned up and projecting. A longitudinal section shows no interruption in the continuity of the interseptal chambers from one end to the other, so that the digestive cavity is probably common to both polyps.

Height, 2.5 to 4 cm.; diameter, 2 to 3 mm.

Off Boca Grande, in 125 fathoms.
Off Key West, in 135 fathoms.
Off Key West, in 138 fathoms.
Off Sombrero, in 152 fathoms.
Off Sand Key, in 154 fathoms.
Off Tennessee Reef, in 174 fathoms.
Off Bahia Honda, in 176 fathoms.
Off Sombrero, in 183 fathoms.

PARACYATHUS M.-Edw. & H.

Paracyathus confertus Pourt.

Paracyathus confertus Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate VI., figs. 11, 12, and 13.

Corallum turbinate, pedicellate; costæ distinct to the base, not prominent, granular. Calicle oblong, concave. Septa crowded, thin, entire, slightly exsert, in five cycles, but with considerable irregularity in some of the systems. Pali numerous, difficult to distinguish from the papillæ of the columella.

Like Caryophyllia, this genus presents so many points of variation that it is very difficult to define a species. I have retained the above name provisionally, not having been able to make direct comparisons with European specimens, with which I have little doubt it will ultimately be identified. Specimens of a Paracyathus from the Azores do not differ from mine.

Off Tortugas, in 36, 37, 60, and 68 fathoms.
Off Carysfort Reef, in 52, 60, and 63 fathoms.
Off Conch Reef, in 60 and 77 fathoms.
Off Alligator Reef, in 79 fathoms.
Off The Samboes, in 93 fathoms.
Off Sand Key, in 125 fathoms.
Off Double-Headed Shot Key, in 315 fathoms (dead).

Paracyathus? folliculus Pourt.

Paracyathus? folliculus Pourt.
Stephanophyllia folliculus Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Corallum free, without mark of adherence, broader at the base than at the calicle. Costæ broad, granulated, flat, nearly meeting at the centre of the base; the primaries continuous, the tertiaries united to the secondaries. Intercostal furrows narrow. Calicle circular or subhexagonal, slightly concave. Septa in six complete systems and three cycles, covered with large tubercles, not exsert (in the only specimen obtained the edge of the septa, and the summit of the pali and of the columella, appear to have been injured or abraded during the life of the animal). The primaries and secondaries meet in the centre with an indistinct columella, the tertiaries connect with

the secondaries about the middle of the radius. There are indistinct traces of pali.

I have satisfied myself that the former determination of this coral was wrong; it is probably a free Paracyathus, not very unlike *P. caryophyllus* M.-Edw. and H.

Height 3 mm., diameter of calicle 2 mm.

Off the Samboes, in 237 fathoms.

LEPTOCYATHUS M.-Edw. & H.

Leptocyathus Stimpsonii Pourt.

Plate III., figs. 1, 2, and 3.

Corallum free, more or less hemispherical, without mark of adherence. Costæ equal, continuous with the septa, without definite boundary, finely serrate and spinous, deeply separated by very narrow furrows, so that the wall proper is invisible. The primary costæ reach nearly to the centre, those of the fourth order embrace and unite with those of the third, and the resultant costæ of two half-systems unite below the secondaries. This arrangement is seldom regular except in the young, as the base of most of the old ones has the appearance of having been broken and mended, thus introducing much confusion in the arrangement. Calicle circular; fossa small and not deep. Septa subequal, finely denticulate, the teeth becoming larger towards the interior, crowded, in six systems and four cycles; the arrangement of the different orders as in the costæ. Pali in front of the secondary septa very distinct, those of the other orders scarcely distinguishable from the columellar processes, of which there are from six to twelve, crowded and irregularly prismatic.

The young are almost spherical, the calicle being quite small; they resemble a Melocactus deprived of its spines.

The polyp is of a delicate pink or sometimes greenish color, with simple conical tentacles.

Diameter 6 to 7 mm.; height about 3 mm.

Abundant in 60 fathoms off Conch Reef; one specimen in 160 fathoms off Tennessee Reef.

This coral is referred to the genus Leptocyathus with some doubt, as its denticulate septa would really remove it altogether from the family of Turbinolidæ.

THECOCYATHUS M.-Edw. & H.

This genus, established by Milne-Edwards and Haime, contained heretofore only three species, fossils of the Upper Lias; there is but one other genus of Turbinolidæ as old as this one, the family having received its greatest development in the tertiary and present epochs. No representative of the genus Thecocyathus is known from any of the formations intermediate between the Lias and our epoch. Recent forms being found now present, therefore, a rare instance of the reappearance of a genus apparently extinct through a considerable succession of ages.

The two species described below agree in their shape, which is that of a short cylinder. To maintain this shape, notwithstanding the increase of the diameter of the calicle, a peculiar arrangement is necessary. From every one of the interseptal chambers starts a hollow root, homologous to those of Rhizotrochus, but never detached, nor visible externally. These roots form a concentric circle round the original base of attachment. As the coral grows new roots are formed higher up, and a new circle concentric with the preceding is formed. In full-grown specimens five or six of these circles are produced. (See Plate V., figs. 3 and 4.) All the interseptal chambers emit these canals (which are filled up by extensions of the polyp body), thus differing from Rhizotrochus, in which only twelve chambers are thus provided; in our *R. fragilis* only once during the whole growth, in *R. typus* apparently twice.

A similar but less pronounced arrangement exists in Paracyathus, and probably in other corals.

In the Bulletin of the Museum of Comparative Zoölogy, No. 7, I had confounded two species under the name of *T. cylindraceus*. I have since recognized the differences, after examining a pretty large number of specimens.

Thecocyathus cylindraceus Pourt.

Thecocyathus cylindraceus Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate II., figs. 14 and 15.

Corallum attached by a broad base, short, cylindrical. Costæ generally visible through the epitheca, which reaches to, and sometimes over, the border of the circular calicle. Fossa shallow. Septa *very*

finely dentate, slightly sinuous, granulated, not exsert, forming six systems of four cycles; one of the systems sometimes incomplete. Pali thick, with sinuous surfaces, fronting all the septa but those of the fourth cycle; those of the second largest. Columella thick, formed of a dense mass of papillose processes, arranged in rather indistinct rows coinciding with the pali.

Height 13 to 19 mm.; diameter 9 mm.

In 100 to 200 fathoms off the Florida Reef; less common than the following species. Full-grown specimens rather rare.

Thecocyathus lævigatus Pourt.

Plate V., figs. 3 and 4.

General form, costæ, and epitheca not different from preceding species. Septa in four cycles and six incomplete systems, the fourth cycle remaining undeveloped in one of the systems and two half-systems. Septa smooth and as if enamelled, with very fine granules and *entire border*. Pali only before the septa of the third order, and seldom complete. Columella papillose, formed of four to ten pointed and smooth processes.

Height 9 to 13 mm., diameter 6 mm.

Rather abundant in 100 to 200 fathoms off the Florida Reef; also found living in 315 fathoms off Double-Headed Shot Keys.

TROCHOCYATHUS M.-Edw. & H.

Trochocyathus? coronatus Pourt.

Platytrochus coronatus Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate VI., fig. 16.

Corallum free, cylindrical; horizontal base with a knob in the middle. Primary and secondary costæ having each a large tubercle at the junction of the vertical wall with the base. Calicle circular. Septa in six complete systems and four cycles, meeting in the centre. Tertiary septa frequently but not regularly coalescing with

the primary or secondary ones. Columella probably papillose (nearly destroyed in the specimen).

Diameter 16 mm.; height, including central knob, 10 mm.

One dead and badly preserved specimen was brought up by the lead some years ago, by one of the United States Coast Survey parties, from 460 fathoms, in lat. 30° 41′ N. and long. 77° 3′ W.

This specimen was described as a Platytrochus by a mere inadvertence on my part. I place it now among the Trochocyathi with a doubt, since the specimen has lost its columella and pali, if it had any. Its general appearance would place it near *T. armatus* M.-Edw. & H., differing from it in having only knobs instead of spines, and equally on the primary and secondary septa.

DELTOCYATHUS M.-Edw. & H.

Deltocyathus Agassizii Pourt.

Deltocyathus Agassizii Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate II., figs. 1 to 5; and Plate V., figs. 9 and 10.

Corallum discoidal, free at all ages. Wall nearly horizontal, or flat conical, sometimes with a nipple-shaped projection in the centre. Costæ well marked, covered with spiny or smooth granules, generally subequal, but sometimes the primary costæ much larger and prolonged beyond the edge, forming a star. Septa in six complete systems and four cycles, covered with small spinous tubercles. Pali of the first, second, and third cycles projecting generally higher than the septa to which they are soldered at the base. The pali of the first cycle short, those of the third joined to those of the second, but the point of junction not being exsert, the V, or delta, is not as apparent as in the fossil species. Columella papillose and small, rising from the primary and secondary pali which meet in the centre. (The columella is represented a little too large in fig. 1, and particularly fig. 2, of Plate II.)

This coral has been pronounced by Dr. Duncan identical with the fossil species *D. italicus*. They are certainly very closely allied; but as far as I have been able to compare them, they are readily distinguished by the costæ, which in *D. italicus* are formed of large grains, and have thus a moniliform appearance, whilst all the Cuban and Floridan specimens, although in other respects very variable, have

the costæ covered with very fine sharp granulations. The columella of the recent species is also much less developed than in the fossil, and the pali more slender and delicate.

Among the varieties, those with large and prolonged primary costæ (Plate II., figs. 4 and 5) appeared to present therewith good specific characters, until a large specimen was found which had enlarged and projecting primary costæ until about half grown, and then suddenly changed to the form with equal costæ. One mutilated specimen has the primary costæ prolonged into horn-like appendages as long as one fourth the diameter of the calicle, and surmounted with a smaller prong, directed upwards. (Plate V., figs. 9 and 10.)

The polyp of a large living specimen dredged in 115 fathoms, off the Tortugas, was whitish, with brown stripes between the pali and on the secondary septa. The tentacles were club-shaped, short, placed in the depressions between the septa and the pali.

On the Florida side of the channel most of the specimens were immature. Until half grown the wall forms a regular cone of very large aperture (about 110°); at a later period it becomes flatter and saucer-shaped.

One single specimen was obtained living, and was also the largest; 13.5 millimeters in diameter.

Off Conch Reef, in 60 fathoms.
Off Alligator Reef, in 113 fathoms.
Off Tortugas, in 115 fathoms.
Off Chorrera (Cuba), in 270 fathoms.
Off Rebecca Channel, in 290 fathoms.
Off Marquesas, in 296 fathoms.
Off Boca Grande, in 327 fathoms.

DESMOPHYLLUM Ehrbg.

Desmophyllum Cailleti Duch. & Mich.

Desmophyllum Cailleti Duch. & Mich. Suppl. Mém. Coral., 1864.

Six fine living specimens of this coral were obtained in 315 fathoms, off the Double-Headed Shot Keys. They agree with the definition of the above species, but are more elongated and more contracted at the base than the figure of those authors. Wall and septa are very thin and fragile, and the whole coral resembles *Rhizotrochus fragilis* very much. The largest specimen is 23 millimeters in height, and 13 in diameter at the calicle.

Desmophyllum solidum Pourt.

Plate V., figs. 5 and 6.

Corallum conical, pedunculate, heavy. Septa very thick, finely granulated, in six complete systems and three cycles. The primaries and secondaries are nearly equal, somewhat exsert, the tertiaries are lower, but twice as thick; all the septa are so nearly in contact that the interseptal chambers are almost obliterated, except near the middle of the calicle. Costæ also very thick, continuous with the septa, not continued far from the border of the calicle.

Height 11 millimeters, diameter eight. One specimen (in a semi-fossil condition) found with the preceding species in 315 fathoms, off Double-Headed Shot Key. There are several species of this type with thick septa in the tertiary beds of Sicily, which have been described by Seguenza; none, however, appears to be identical with this.

RHIZOTROCHUS M.-Edw. & H.

Rhizotrochus fragilis Pourt.

Rhizotrochus fragilis Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate IV., figs. 1 to 4.

Corallum simple, pedunculate, straight or slightly curved, regularly conical. Calicle subelliptical, deep. Six complete systems of septa, four cycles. Septa very thin, not exsert, finely granulated; those of the first and second order meeting in the centre, and united for about half their height. Costæ not prominent, no epitheca. Hollow roots attached to the costæ of the second order in pairs, at about one third or one half the height of the corallum, and continued down to the peduncle, where they slightly expand; they are never detached from the wall. The whole corallum very thin and fragile.

The young at first form a six-sided rounded cell, wider at the base of attachment than at the top. The six primary septa reach only half-way to the centre. At the next stage they unite in the centre, frequently leaving a small open space in their middle. Simultaneously or after the appearance of the secondary septa, a

circular wall arises from the floor and separates the interseptal chambers in two, the outer portion becoming the rootlike appendage. The cavity of the roots opens freely into the interseptal chambers (Plate XIV., fig. 3), and is occupied by a fibrous extension of the polyp. In old specimens the cavity becomes much reduced by the thickening of the walls.

The color of the polyp is greenish, or pale brick-red.

This coral was obtained in about forty different casts along the Florida reef, the least depth in which it was found being 49 fathoms, the greatest 324. The greatest abundance was between 100 and 200 fathoms.

Height 2 to 2.8 cm., diameter of calicle 1.5 to 2 cm.

TROCHOSMILIDÆ.

Trochosmiliaceæ M.-Edw. & H.

For reasons elsewhere stated, I prefer to elevate this group to the rank of a family, instead of leaving it among the Astræidæ as a mere section of the subfamily of Eusmilinæ, the place assigned to it by Milne-Edwards and Haime. Its affinities are partly with the Astræidæ and partly with the Turbinolidæ. We are not sufficiently acquainted with the value of the characters connecting it with either to say positively which of them ought to have the preponderance. As a family, it appears homogeneous, but the order or suborder to which it ought to be attached can be left undetermined for the present.

The principal character by which to separate the Trochosmilidæ from the Turbinolidæ is the presence in the former of dissepiments closing the interseptal chambers. In a large number of them they are of a very rudimentary character, and no more developed than they are occasionally in true Caryophylliæ, where I have observed similar structures secreted abnormally to exclude parasites.

The mode of propagation observed in three of the species here described, namely, a gemmation from the interior of the calicle, recalls the peculiar intracalicinar gemmation of the Rugosa, and does not prevail among any of the families of corals of the present epoch.

CERATOCYATHUS Seguenza.

Having received, through the kindness of Mr. J. G. Jeffreys, some specimens of *Ceratocyathus ornatus* Seguenza, from the dredgings of the Porcupine Expedition off the West Coast of Ireland, I have satisfied myself that the genus does not belong to the family of Caryophyllidæ at all, but to Trochosmilidæ. If the European species from the deep-sea dredgings and the Sicilian tertiary beds does not show very distinct dissepiments (at least in the specimen of which Mr. Bicknell made a section for me), it is because the interspaces have been filled up, as a careful inspection shows plainly. The pali, which give to these corals so striking a resemblance to the typical Caryophylliæ, are found, when traced to their origin, to be formed by lobes of the septa, and not by independent growths rising from the bottom of the calicle.

Ceratocyathus prolifer Pourt.

Plate III, figs. 8, 9, 10.

Corallum free when adult, conical, curved, showing no trace of attachment. Costæ finely granulated. No trace of epitheca. The wall rather thick and of compact texture. Calicle circular or slightly elongated in the direction of the curvature; fossa moderately deep. Septa finely granulated in six systems and five cycles, but the fifth cycle generally incomplete in some of the systems. The septa of the third order, and sometimes those of the fourth, have a paliform lobe, which in older specimens becomes merged in the columella. (This is the case in fig. 9.) Dissepiments rather massive, about eight or nine occurring in a chamber (Plate III., fig. 10). The base of the coral has a tendency to become filled up. Columella spongy with papillose convex surface; in the young it is little developed, and sometimes lamellar, so that an isolated specimen would be liable to be classed as a Placosmilia.

The propagation is by buds inside of the calicle of the parent, not unfrequently two or three growing out at the same time, but in such cases one of them outgrows and stunts the others. The parent is probably killed by the growth of the offspring, which fills the whole calicle before becoming free, but the wall being very strong

it is never broken as in *Parasmilia Lymani*. Out of twenty-four specimens obtained, nine show this mode of multiplying.

Height 15 to 20 mm., diameter 12 mm.

Found only in one locality, off French Reef, in 45 fathoms.

Parasmilia mitans Duch. & Mich. is perhaps nearly related to this species, but the description and figure are too vague for identification.

PARASMILIA M.-Edw. & H.

Parasmilia Lymani Pourt.

Plate VI., figs. 8, 9, 10.

Corallum more or less elongated, conical, nearly always attached to a fragment of the parent, otherwise free. Wall very thin. Costæ small, finely granulated, subequal or alternately larger and smaller, equally developed from base to top. Calicle circular or slightly elongated or irregular. Fossa moderately deep. Five cycles of septa, and six very irregular systems, having often the appearance of a greater number; the septa entire, moderately exsert, with few rather large and flat granules joined sometimes in oblique ridges. The internal edge of the septa is deeply divided into lobes forming false pali and sometimes a false columella (Plate VI., fig. 10). The paliform lobes are formed by the penultimate septa; whilst the twisted ones, simulating a columella, rise from the other cycles, except the last. Dissepiments rudimentary, membraniform, nearly horizontal, only two or three in number in an interseptal chamber. They are too faintly represented in fig. 10.

The propagation is by buds on the septa in the interior of the calicle, in the parent, the walls of which are burst by the growth of the young; the latter carrying a fragment attached to the base generally through life.

The largest specimen (incomplete at the base) is 4 cm. high, 18 mm. in the greatest and 13 in the smaller diameter.

Off Elbow Reef, in 70 fathoms.
Off Alligator Reef, in 79 fathoms (dead specimen).
Off the Samboes, in 96 fathoms.
Off Alligator Reef, in 110 fathoms.
Off Conch Reef, in 117 fathoms.
Off Alligator Reef, in 147 fathoms.

Parasmilia variegata Pourt.

Plate I., fig. 13.

Corallum simple, free, conical, often deformed; the irregular shape resulting from the young being originally attached to fragments of the parent, which become gradually covered over and incorporated into the base. No epitheca, costæ distinct to the base, flat, finely granulated, those of the third order somewhat broader and more prominent than the others. Calicle oval, with moderately deep fossa. Septa in six complete systems of four cycles, considerably exsert and very unequal; those of the first and second order being closely connected at the wall with those of the fourth and fifth respectively, and rising high above those of the third order, which are the lowest of all. Septa entire on their upper edge, but deeply laciniated in the interior of the calicle, which thus becomes filled with a false columella of curled and twisted septal processes. The primary and secondary septa are colored of a dark purple, which color continues some distance down the corresponding costæ. Those of the fourth cycle are lighter colored, with a dark spot on the corresponding costæ, a short distance below the border. Those of the third order are white, with the same dark spot on the costa. Dissepiments not observed, none in the upper three fourths of the corallum.

The young bud out of the calicle of the parent, which is split in consequence.

Height 15 to 16 mm.; diameters of calicle 10 and 13 mm.

Off Conch Reef, in 60 fathoms.
Off Carysfort Reef, in 63 fathoms.
Off Conch Reef, in 77 fathoms.

CŒLOSMILIA M.-Edw. & H.

Cœlosmilia fecunda Pourt.

Plate I., fig. 12; Plate III., figs. 4 and 5; Plate VI., figs. 14 and 15.

Corallum elongated, conical, irregularly bent, showing sometimes a succession of slight swellings and contractions, attached by a slightly thickened base. Costæ finely granulated, rather obsolete near the base. Calicle circular or subelliptical, with deep fossa. Septa entire, granulated finely, not exsert, in six systems and four

cycles, the fourth developed in part of the systems only. The inner edge of the septa sends out trabiculæ uniting together to form the rudimentary columella, which is, however, frequently absent. Dissepiments thin but complete, moderately abundant. Gemmation external, at all heights, but generally near the calicle; abundant, one specimen having as many as eleven buds: some good-sized specimens, however, show none; as, for instance, the one figured on Plate III.

Height of largest specimen 4 cm., diameters of calicle 6 and 7 mm.

West of Tortugas, in 68 fathoms.
Off Havana, in 270 fathoms.
Off Double-Headed Shot Key, in 315 fathoms (dead specimen).

The generic affinities of this coral are a little doubtful. By its general aspect it reminds one of Cladocora, or rather Goniocora; but according to the classification generally adopted, it is widely separated from it on account of the entire border of the septa. In its general features it approaches the genus Onchotrochus Duncan; but this is described as destitute of endotheca, and therefore placed among the Turbinolians.

Family OCULINIDÆ Verrill.

Oculinaceæ M.-Edw. & H.

By constituting the section of Stylasteraceæ of Milne-Edwards and Haime into a separate family, the Oculinidæ become restricted to the Oculinaceæ of these authors, and form thus a much more homogeneous and natural group.

OCULINA M.-Edw. & H.

Oculina Lamk. (pars).

Oculina varicosa Lesueur.

Oculina varicosa Lesueur.
Oculina varicosa Dana.
Oculina Petiveri M.-Edw. & H.
Oculina disticha Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate VI., figs. 3 and 4.

I have become convinced that the specimens described by me as

Oculina disticha were fragments of the younger branches of *Oculina varicosa* Les. They were obtained

Off Conch Reef, in 40 fathoms.
Off American Shoal, in 43 fathoms.
Off French Reef, in 50 fathoms.

The description and figure of Lesueur are so imperfect, that they may apply to almost any species of the genus. Dana's description, however, really establishes the species, and is prior to Milne-Edwards and Haime's, who evidently referred to the same object. Why they should make Dana's species a synonyme of *O. diffusa* is not very clear.

Oculina tenella Pourt.

Plate V., figs. 11 and 12.

Corallum branching irregularly, slender. Cœnenchyma finely granulated. Costæ distinct only on the border of the calicles, which are circular, irregularly alternate, very prominent, about one diameter apart, and as wide or slightly wider than the branches. Fossa moderately deep. Septa finely serrated, slightly exsert in six systems and three cycles. Pali before the primary and secondary septa. Columella papillose, more deeply sunk than the pali.

Smaller branches about 2 mm. in diameter. Calicles 2 to 2.5 mm.

Off Tortugas, in 36 fathoms.

Oculina diffusa Lamk.

Was obtained living as deep as 15 fathoms.

DIPLOHELIA M.-Edw. & H.

Attention has lately been drawn by Dr. Duncan to the difficulty of distinguishing from each other the genera Diplohelia, Amphihelia, and Lophohelia of Milne-Edwards and Haime. Like others of the genera established by these authors and based on very few species, they become very perplexing as our collections increase and the distinctive characters are found not to be so precise as they were at first enounced. My opportunities for the study of this group have

not been very extensive, still they are probably sufficient to illustrate and partly confirm Dr. Duncan's views.

The following are the species examined, keeping the usual generic names: —

1. *Lophohelia prolifera* M.-Edw. & H., Florida and North European seas.
2. *Lophohelia exigua* Pourt., Florida.
3. *Amphihelia oculata* M.-Edw. & H., North European seas.
4. *Amphihelia carolina* Pourt., Cuba.
5. *Amphihelia infundibulifera* Lamk. sp., East Indies?
6. *Amphihelia miocenica?* Seg. (*A. ramea* Sars), Norway.
7. *Diplohelia raristella* M.-Ed. & H., fossil, France.
8. *Diplohelia profunda* Pourt., Florida.

The first and second have no columella, entire septa, thin cænenchyma (but quite distinct); the third has also entire septa, a small columella, thick cænenchyma; the fourth, entire septa, no columella, thick cænenchyma; the fifth, serrate septa, no columella, thin cænenchyma; the sixth, serrate septa (?), a columella, thin cænenchyma; the seventh and eighth, serrate septa, small columella, moderate cænenchyma.

It is evident from this arrangement, that, giving to the above characters the weight usually attached to them, these seven species would be assigned to at least five distinct genera. The distinction on account of presence or absence of cænenchyma falls to the ground, since it is only a question of more or less. The same might be said of the presence or absence of columella, since it is almost absent in some of the corallites of *Amphihelia oculata* for instance, and, on the other hand, rudiments can be found in some corallites of *Lophohelia prolifera*. There remains, then, only the serrate or entire edge of the septa, which in some families of corals constitutes a character for their division into subfamilies. It is in many cases a very unsatisfactory character, particularly to the paleontologist, and has given rise to serious mistakes, an example of which will be shown in another part of this paper (Astrocænia).

For the present, and considering the small number of species under comparison, it seems proper enough to combine the genera Lophohelia and Amphihelia into one, as there is really no permanent character to separate them. The genus Diplohelia might, however, be kept for those species in which the corallites never appear individualized, even when young, but form, as it were, part of the branch with the same diameter throughout. The character is not a very good one, perhaps, still there is something distinctive in it which strikes at first sight. If living specimens of *Diplohelia profunda* can be procured (mine are all more or less worn), some other characters may be detected.

This arrangement seems to me more natural than to combine Amphihelia and Diplohelia into one genus, and leaving out Lophohelia, as Dr. Duncan has done.

Diplohelia profunda Pourt.

Diplohelia profunda Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate VI., figs. 6 and 7.

Corallum branching, cylindrical, finely granulated or striated, particularly on younger branches and near the calicles, where the granulations assume the shape of rudimentary costæ. Calicles slightly projecting, very deep, irregularly alternate, and very distant from each other. Septa in three cycles and six complete systems, subequal, not exsert, finely serrate and tuberculated, nearly meeting at the bottom of the fossa. Columella formed of six or seven club-shaped styles, not very distinct from the septa. Height, 3 or 4 cm.; diameter of branches, 4 mm.; of calicles, 2.5 mm.

This species resembles *D. raristella*, but has fewer, deeper, and larger calicles. It seems to differ also from *D. Doderleiniana* Seguenza by the same characters; in fact, the difference between Seguenza's species and *D. raristella* is not very apparent.

Off Havana, in 350 fathoms.
Off Bahia Honda, Florida, in 324 fathoms.
In lat. 28° 24′ N., long. 79° 13′ W., in 1050 fathoms.

In all cases, dead and more or less worn specimens only were obtained.

LOPHOHELIA.

Lophohelia + *Amphihelia* M.-Edw. & H.

Lophohelia prolifera M.-Edw. & H.

Lophohelia affinis Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate I., figs. 3, 4, 5.

My species is identical with *L. prolifera*, as numerous comparisons with specimens from European seas have shown.

Off Coffin's Patches, Florida, in 195 fathoms.
Off Double-Headed Shot Keys, in 315 fathoms (dead fragments).

Lophohelia exigua Pourt.

Plate I., figs. 6 and 7.

Corallum branching; the corallites alternate, forming angles of 70°–75° with their predecessors, proportionally shorter and more open than in *L. prolifera*. Wall smooth or very finely granulated. Costæ sharp and prominent, but not extending far downward. Calicle circular, well opened, very deep. Septa thin, slightly exsert, in six systems and four cycles, the last almost rudimentary.

Height, 3 to 4 cm.; height of single corallites, 4 to 5 mm.; diameter of calicle, 4 to 6 mm.

Off Tortugas, in 36 and 79 fathoms.
Off Pacific Reef, in 287 fathoms (dead fragments).

The fragment from the last locality is doubtful, being much worn.

Lophohelia Carolina Pourt.

Corallum branching, with smooth and very faintly striated cœnenchyma, dense and heavy. Calicles regularly alternate, costæ distinct on the border of the calicles only. Calicles prominent, not very deep; septa with entire border, not exsert. Six complete systems, three unequal cycles, the first nearly meeting in the centre; no columella. The branch from which this description is taken is 18 cm. long, 8 mm. in diameter in the thickest part, calicles 4 mm.

This species is named according to the desire of Mr. R. Arango of Havana, who sent it to the Museum. The depth from which it was obtained is not stated, but it came probably from a fisherman's line or net, as many other interesting specimens in that gentleman's collection.

Family STYLOPHORIDÆ Pourt.

Stylophorinæ M.-Edw. & H., 1857.
Pseudoculinæ M.-Edw & H. Ann. Sc. Nat., 3d Ser., Vol. XIII., 1850.

This group was placed by Milne-Edwards and Haime at the end of the Oculinidæ, as a subfamily intermediate between the Oculinidæ and the Astræidæ, more nearly allied to the former than to

the latter. This relationship is based chiefly on the density of the cœnenchyma, but this is a very variable character, and some genera left by the same authors among the Astræidæ proper, such as Cyphastræa for instance, have it just as compact as Stylophora, though less abundant. The reliance on this character alone has induced Milne-Edwards and Haime to establish the two genera Axohelia and Madracis, and to place the one among the Oculinidæ proper and the other among the Stylophorinæ, whilst in reality the two genera cannot be separated by any other characters.

The group, on the whole, does not appear to be allied closely enough either to the Oculinidæ or the Astræidæ to warrant their combination with the one or the other as a subfamily. It is better for the present to leave it as a small intermediate family.

MADRACIS Pourt.

Madracis M.-Edw. & H.
Axohelia M.-Edw. & H.

A comparison of several representatives of the genus Madracis with an Axohelia from the West Indies, very closely allied to, if not identical with, *Axohelia myriaster*, M.-Edw. & H., has convinced me that the two genera cannot be separated, and much less placed in different subfamilies. The only difference is in the cœnenchyma, more abundant and compact in the one than in the other; but this is a difference only in degree, for in both forms the cœnenchyma becomes solid, but the interseptal chambers do not fill up completely as in the true Oculinidæ. The younger parts of *Madracis decactis* show the space between the calicles proper and the mural ridge occupied by large vesicular spaces, which afterwards become gradually filled up.

I propose to retain the name Madracis for the two genera combined.

Madracis asperula M.-Edw. & H.

Plate VII., fig. 4.

The specimens which we refer to this species are in general a little slenderer than the one figured in the *Annales des Sciences*

Naturalles, but there are no sufficient grounds for separating them specifically.

The color is variable, sometimes light brown with black or dark brown calicles, or purplish pink of different shades, with or without darker calicles.

West of Tortugas, in 36 fathoms,
Saint Nicholas Channel, off Bahia de Cadiz, in 120 fathoms.

Madracis decactis Verrill (*Astræa decactis* Lyman, Proc. Bost. Soc. Nat. Hist., Vol. VI., 1857), Plate VII., figs. 1, 2, and 3, is found to a depth of 17 fathoms. It is generally thin and incrusting, but also rising in club-like masses. A specimen received from Mr. R. Arango, in Havana, forms thick branches bluntly expanded at the end, 6 cm. high, and 4 cm. in diameter.* *Stylophora incrustans* Duch. & Mich. I strongly suspect to be a young *Madracis decactis*.† and *Reussia lamellosa* Duch. & Mich., the full-grown form.‡

Stylophora mirabilis Duch. & Mich. is a Madracis also, with massive cœnenchyma.

The Museum of Comparative Zoölogy has also received from Mr. Arango, in Havana, specimens of a coral, which agrees with the description of *Axohelia myriaster*, M.-Edw. & H. It differs from *Madracis mirabilis* chiefly by its striated cœnenchyma and larger calicles, which, instead of being prominent, are rather sunk below the surface.

* The polyp is purplish brown, tentacles tipped with white; disk emerald green, mouth yellow. The mural lines separating the polyps are tipped with white. The tentacles are in one circle, five of them large, prominent, and almost spherical when fully expanded, the white tip swelling up in that shape. The other tentacles are in groups of three between the larger ones, the total number being thus twenty, or double the number of the septa. There are thus five primary, five secondary, and ten tertiary tentacles. The disk, when fully expanded, projects in the shape of a cone, with the mouth at the apex. The water is kept in a whirling motion over the mouth by ciliary action. The animal bears handling and taking out of the water very well, expanding again after a few minutes of rest.

† Duchassaing et Michelotti, Supplément au Mémoire sur les Coralliaires, Plate IX., fig. 3, is evidently a magnified portion of *Stylaster elegans*, represented on fig. 4. Fig. 2 may be intended to represent *Stylophora incrustans*, the numbers having been misplaced.

‡ There is again here (Duchassaing et Michelotti, Mémoire sur les Coralliaires des Antilles) a confusion in the numbering of the figures, and in the figures themselves. One of the generic characters of Reussia (differing in no way from those of Madracis) consists in having always ten septa. Fig. 9 of Plate IX., purporting to be a magnified portion of *Reussia lamellosa*, shows from fourteen to twenty-seven! Fig. 8 agrees well with the large specimens of *Madracis decactis* from Havana.

Family ASTRÆIDÆ M.-Edw. & H. (pars).

As the typical Astræidæ are not represented in the deep-sea fauna, it would lead too far to attempt a revision of the family or even suggestions towards it in this place.

But one group of genera I have felt justified in separating from the Astræidæ, as I have remarked before, under the head of the Trochosmilidæ. It may remain for the present an open question if they ought to form a family by themselves, and if so, what place that family ought to occupy and what other corals might be added to it.

Most of the Astræidæ described here will be found to be adventitious, having been drifted from shallow water.

STYLINACEÆ M.-Edw. & H.

Galaxea eburnea Pourt.

Plate III., figs. 6 and 7.

Corallites cylindro-conical. Wall smooth, shining, concave between the very flat costæ of the two first cycles; no costæ for the third cycle. Calicle regularly dodecagonal: fossa small and deep. Septa smooth, very little exsert, rather thick, very regular, in six systems and three cycles. Dissepiments few and deeply seated. Height 2 cm., diameter 6 mm.

This description applies to the only specimen obtained off Havana in 270 fathoms. Although fresh, it had no trace of the peritheca except discoloration for about half the height. Since then I have seen specimens from the collection of Mr. R. Arango in Havana, having four cycles of septa in some of the systems, costæ for all the cycles, and cellular peritheca reaching to about one third the height. They were also detached corallites. There is probably but one species, notwithstanding the differences indicated.

CLADOCORACEÆ M.-Edw. & H.

CLADOCORA M.-Edw. & H.

Cladocora (pars) Ehrbg. & Hemp.

Cladocora debilis M.-Edw. & H.

Specimens of a Cladocora somewhat different from *C. arbuscula*, common in shoal water, are referred to this species. They are slenderer, less branching, have a more shallow fossa, well-developed pali and columella, and more exsert septa.

Off Sand Key, in 26 fathoms.
Off French Reef, in 45 fathoms.
Off Elbow Reef, in 49 fathoms.
Off Carysfort Reef, in 63 fathoms.

Cladocora arbuscula, as far as my observations go, is found from low-water mark to 13 fathoms. It is possible that *Cladocora debilis* may be merely a deeper water variety of this species.

ASTRANGIACEÆ M.-Edw. & H.

PHYLLANGIA M.-Edw. & H.

Syndepas Lyman. Proc. Bost. Soc. Nat. Hist., VI. p. 274, 1857.

Phyllangia americana M.-Edw. & H.

Syndepas Gouldii Lyman l. c.
Stellangia reptans? Duch. & Mich.

Off Double-Headed Shot Key (Elbow Key), in 315 fathoms.

Dead specimens, rather worn, were dredged up with quite a number of other dead corals at this place, shoal-water and deep-water species being mixed together. The locality is very near the edge of the Salt Key Bank, at the foot of a very steep submarine slope, and washed by the edge of the Gulf Stream.

ASTRANGIA M.-Edw. & H.

Astrangia solitaria Verrill.

Astrangia solitaria Verrill. Bull. Mus. Comp. Zoöl., No. 3.
Caryophyllia solitaria Lesueur. Jour. Phil. Acad. Nat. Sc., I., p. 180, Pl. VIII., fig. 11, 1817; and Mém. du Mus., T. VI., p. 273, Plate XV., fig. 1.
Astrangia phyllangioides? Ducu. & Mich.

Dead specimens off Double-Headed Shot Key, in 315 fathoms.

The same remarks apply to this species as to *Phyllangia americana*. Both are rather common shoal-water species.

COLANGIA Pourt.

Corallum immersed in an expanded epithecal membrane, forming several successive stories, following the growth of the coral. Primary and secondary septa entire; those of the lower cycles denticulate. Well-developed pali in front of the tertiaries. Columella lamellar or papillose, not much developed. The genus is chiefly distinguished by the highly developed epitheca from Phyllangia, which has none, or only a false one formed by a coralline growth.

Colangia immersa Pourt.

Corallum incrusting, in loose clusters, the corallites tending to develop in rows, immersed in an epithecal membrane, stretching out horizontally from the margin of the calicles, and forming anew when the corallites increase in height. No costæ visible. Calicles round or somewhat elongated; fossa shallow. Septa thin, smooth, with very few granules, in six systems, generally complete. Four cycles. Primaries exsert, with straight perpendicular inner edge. Secondaries not exsert, having, like the primaries, an entire edge. Tertiaries with rounded denticulations. Pali prominent, thin, rounded, in front of tertiary septa. Columella in shape of an irregular lamella with a few lateral papillæ, or sometimes simply papillary.

Diameter of calicles, 7 mm.

Like the other Astrangiaceæ, this is a shallow-water form, found on

the reefs, though rather rare. Dead specimens were found off Double-Headed Shot Key (Elbow Key) in 315 fathoms, with the preceding species. The association of three allied shoal-water forms transported to this deep-water locality is rather singular.

Family STYLASTERIDÆ Gray.

Stylasteraceæ M.-Edw. & H. (pars).

This family was first established by Gray (Ann. & Mag. Nat. Hist., Vol. XIX., 1847), for the genus *Stylaster* alone. M.-Edwards and Haime made of it a group or subfamily (*agèle*), and placed it among the Oculinidæ under the name of Stylasteraceæ. They have, however, left out the genus *Errina* Gray altogether, placed *Distichopora* among the genera of doubtful position, but included *Acrohelia*, which is a *Madracis*. Otherwise the limits of the group are the same which we shall use.

Professor Verrill first recognized the close affinity of Distichopora, Errina, and Stylaster (Bull. Mus. Comp. Zoöl., No. 3, 1864). In his "Notes on Radiata" (Trans. Conn. Acad., Vol. I., 1870) he adopted a suggestion of mine to make a distinct family of the Stylasteridæ, which he places in his suborder of Oculinacea, both of us overlooking the fact that Gray had long before already established it.

The association of the Stylasteridæ with the Oculinidæ does not appear natural, and a closer examination of the structure seems to warrant their removal from that vicinity. The cœnenchyma is found, on close examination, to be abundantly perforated; this can be seen more distinctly in *Allopora miniata* (and best in dead and bleached specimens) than any other form that I have examined, but after proper preparation there is no difficulty in recognizing that structure in all the genera. The best way is to prepare a section and brush it over with ink or some other colored liquid, which will fill the fine canals and show them to pervade the whole cœnenchyma, anastomosing among themselves and communicating with the surface and with the interior of the calicles.

According to this character we should be warranted in placing the Stylasteridæ among the Perforata, were we to follow M.-Edwards and Haime's system implicitly; but this section contains so heterogeneous an assemblage of families, that it will most certainly have to be dismembered. In another place in this paper reasons will be given for separating the Eupsammidæ from the Madreporidæ, with which they have been closely connected. It would be perhaps imprudent, without further research, to associate the Stylasteridæ with the

Eupsammidæ; but besides the porous cænenchyma, there is another character connecting the two families, though in a somewhat remote degree: it is the tendency of the septa to unite by their inner edges and enclose, in the interseptal chamber thus formed, the septa of a higher order. This character, more or less developed in the Eupsammidæ, is carried to excess in the Stylasteridæ, where sometimes the interseptal chambers are so far removed from the central part of the calicle as to lose all apparent connection with it.

The subfamily of Turbinarinæ M.-Edw. & H. has also considerable affinities with the Stylasteridæ, having like them all the septa alike.

In Stylasteridæ the calicle is invaded by the cænenchyma, and in a great measure obliterated as in the Oculinidæ proper. This character was relied upon, together with the fancied solid cænenchyma, for associating these forms; in reality the filling up of the Stylasteridæ is of a different kind; the interseptal chambers, always narrow, are continued down and merge in the fine canals of the cænenchyma, whilst the central fossa is obliterated by the growth of the columella. True dissepiments do not appear to exist.

I have, unfortunately, never succeeded in obtaining a satisfactory view of the living polyp of any of the corals of this family, nor am I aware that it has been observed by others. When it is, our views of the classification may be much modified. The so-called ampullæ, peculiar to this family, were found in the fresh polyp to be filled with a yellow mass resembling the yolk of an egg.

The genera forming this family are the following: Allopora, Stylaster, Distichopora, Cryptohelia (= Endohelia?) Lepidopora, n. g., and Errina. Professor Verrill has also included Axohelia, which I consider identical with Madracis, and which belongs to an entirely different family.

Of these genera, Allopora and Stylaster are very closely allied, differing only by their mode of growth. Stenohelia Kent, a new genus established to receive Allopora madeirensis Johnston, and Stylaster complanatus Pourt., I believe very difficult to maintain, as the passage from the Stylasters with circular calicle to those with an oval one is very gradual, as is also the other character derived from the obliteration of one of the lips of the calicle by the intrusion of the cænenchyma. Cyclopora Verrill has all the fundamental characters of a true Stylaster (the columella is well developed); it leads the way towards Distichopora by its interseptal chambers becoming more separated from the fossa, and the latter assuming a more elongated form; still, the differences from Stylaster proper are scarcely sufficient to warrant a new generic name. Lepidopora, a new genus, forms the passage from Stylaster through Cryptohelia to Errina, which is the

most aberrant genus of the family. The genus Endohelia is the only one of which I have not seen a representative. From the description it seems to be scarcely different from Cryptohelia, except in the extent of the lip-like appendage.

To recapitulate, the characters of the family can be expressed as follows:—

Corallum generally branching, frequently colored, multiplying by gemmation. Calicles small and deep, septa all equal, united by their inner edges, and sometimes containing, in the closed interseptal chamber, rudimentary septa of a higher order; in some genera the septa are merged in the cœnenchyma and the interseptal chambers are at some distance from the calicle. Columella styliform or globular, spongy, and hirsute. Cœnenchyma abundant, finely porous, and permeated by fine canals.

- Stylasteridæ
  - with distinct septa
    - gemmation alternate
      - calicles regular . . . *Stylaster.*
      - calicles labiate . . . *Cryptohelia.*
    - gemmation irregular . . . . . *Allopora.*
  - septa obliterated, interseptal chambers distant from fossa.
    - calicles confluent on edge of corallum . . *Distichopora.*
    - calicles labiate . . . *Lepidopora.*
    - calicles without lip . *Errina.*

STYLASTER Gray.

Stylaster erubescens Pourt.

Stylaster erubescens Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate IV., figs. 10 and 11.

Branching densely, flabellate, not coalescing, rising from a broad encrusting expansion; younger branchlets slender, with rather close-set alternate calicles; older branches much thickened, with calicles in irregular rows on one surface, interspersed with ampullæ. Cœnenchyma smooth. Calicles slightly prominent, 1.2 to 1.5 mm. in diameter, deep. Septa nine to twelve, most frequently eleven, equal, shaped like folds of the wall, joined with each other at a little distance below the edge of the calicle, thus forming pit-like interseptal chambers. Tertiary (?) rudimentary septa in the shape of a hairy fringe, enclosed in these interseptal chambers. Columella deeply sunk, rounded, and hirsute. Color white, with a delicate pink blush when fresh.

Dimensions: height and breadth of flabellum 10 cm., diameter of largest stems 1.5 cm. Rather common between 120 and 324 fathoms off the Florida Reef, on rocky bottom.

Stylaster filogranus Pourt.

Plate V., figs. 13 and 14.

Corallum a dense and elegant flabellum, the branches setting off at an angle of 35° to 40°. Sometimes a few aberrant branchlets out of the plane, very rarely coalescing; the branchlets generally bending slightly out of each other's way. Main branches considerably thickened. Calicles comparatively large, regularly alternate on the terminal branchlets, about one diameter apart; this position is preserved on the larger branches, but on the main stem the calicles become obsolete. Calicles transversely elongated, with prominent outer lip; the inner one almost merged in the cœnenchyma. Septa generally twelve, prolonged rather deeply in the fossa; tertiary rudimentary septa scarcely visible. Columella styliform, hirsute, too deeply seated to be seen from outside. Color light pink, fading into white in the younger branchlets. The color diffused through the entire thickness.

Spread and height of corallum, 10 to 15 cm.; thickest branches, 5 to 10 mm. in diameter; calicles, 0.8 to 1 mm.

West of Tortugas; ? fathoms (label lost).

Stylaster Duchassaingii Pourt.

Stylaster elegans Duch. & Mich.

Plate VI., figs. 1 and 2.

As stated by me in Bull. Mus. Comp. Zoöl., No. 6, the name *St. elegans* was preoccupied by Verrill (January, 1864) when Duchassaing and Michelotti published their *Supplément au Mémoire*, &c. (May, 1864). A Stylaster found near Tortugas in 43 fathoms agrees pretty well with those authors' description and figure, though the latter is not detailed enough for safe identification.

The calicle in this species is quite small and is invaded in its upper half by the cœnenchyma, thus forming a transition to the forms for which Mr. Kent has established his genus Stenohelia.

The color of my specimens was white or pale pink, with bright pink ampullæ.

Stylaster punctatus Pourt.

Corallum subflabellate, slender; cœnenchyma smooth, finely punctate with little pores, looking under the lens like eggshell. These pores are present in all the family, as stated before, but they are more conspicuous in this species than in the others of the genus. Calicles alternate, subpedicellate, but very little larger than the pedicel, always confined to two sides of the branches, upper lip not obliterated, except in the axillæ of the branchlets, where the outer lip also becomes appressed and scalelike. Fossa deep and narrow, columella deeply seated. Septa twelve, as usual in the genus. Color light purple. It differs from *St. roseus*, which it resembles most, by its slenderer branches, smaller and less prominent calicles, more distant from each other, and strictly lateral; deeper fossa, smaller and more concealed columella.

One specimen in 9 fathoms off Orange Key, and another in 315 fathoms off Double-Headed Shot Key, a very unusual range. I suppose the shoaler locality to be the true habitat, as the cast in 315 fathoms produced a great mixture of shoal and deep-water species. The locality is at the foot of a steep slope washed by a strong current. I have also seen it in Mr. R. Arango's collection, in Havana, from an unknown depth.

Stylaster complanatus Pourt.

Stylaster complanatus Pourt. Bull. Mus. Comp. Zoöl., No. 6.
Stenohelia complanata Kent. Ann. & Mag. Nat. Hist., February, 1870.

Plate II., figs. 16 and 17.

Corallum branching, flabellate, not coalescing, slender. Calicles pedicellate, gemmating from the edge of the preceding calicle, generally on alternate sides, so as to give a zigzag form to the branches, but sometimes two or even three corallites rise from the border of the preceding. They are directed towards one of the faces of the flabellum. Calicles compressed in the same plane, their diameters being 1 mm. and .7 mm.; on the larger branches the calicle becomes hidden by the plicated lip raised against the stem. Fossa moderately deep, columella styliform, and surrounded by rudimentary pali. Spiny ampullæ, chiefly confined to the rear side.

Septa twelve, rather exsert, and forming a plicated or scalloped edge to the calicle. Tertiary rudimentary septa in the interseptal chambers.

Color white; specimens in Mr. R. Arango's collection, in Havana, delicate pink.

In 270 fathoms off Havana; not found on Florida coast.

(For other species of this genus, see Appendix.)

CRYPTOHELIA M.-Edw. & H.

Cryptohelia Peircei Pourt.

Cryptohelia Peircii Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate II., figs. 18 and 19.

Corallum arborescent and subflabellate, irregularly dichotomous, slender, finely striated, with minute pores in the striæ. Calicles subpedicellate, of a larger diameter than the stem, all facing to one side. Septa twelve to sixteen, not extending far into the calicle. Columella not visible. The lower border of the disklike expansion of the calicle prolonged into a lip folded over so as to hide the fossa. Some of the calicles inflated and globular, perhaps from the presence of parasites.

Dimensions: height 2 cm. (broken); diameter of stem 2.5 mm., of branchlets 1 mm., of calicles 2 mm.

Off Havana, in 270 fathoms.
Off Sombrero Lighthouse, in 262 fathoms (one specimen, dead.)
Off Bahia Honda, in 324 fathoms (living).
In 600 fathoms, lat. 31° 32′ N., long. 78° 20′ W., fragments brought up by the lead.

ALLOPORA Ehrbg.

Allopora miniata Pourt.

Allopora miniata Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate III., figs. 14, 15, and 16.

Corallum branching, flabellate, the main trunk rather massive and flattened. Surface finely and sharply granular, porous. Branchlets thick and obtuse. Calicles irregularly but densely distributed on one surface of the branches, obsolete on the main trunk. Small ampullæ abundant between the calicles on the younger branches. Calicles slightly prominent, fossa deep, columella large, spherical, hirsute, deeply immersed. Septa from seven to ten, generally eight. Interseptal chambers comparatively large, with very distinct hirsute tertiary septa enclosed, giving to the whole when magnified the appearance of a

calicle surrounded by a number of smaller ones, all provided with columellæ. The edge of the calicle and of the septa is crowded with small sharp points and abundantly perforated. Color brick-red.

The corallum seems to have grown in a horizontal trailing manner, as the lower surface often shows signs of contact with foreign bodies.

Dimensions: length 10 to 15 cm., thickness 1 to 1.5 cm., diameter of calicles 1.2 to 1.5 mm.

Off Tennessee Reef, in 124 fathoms.
Off Coffin's Patches, in 195 fathoms.

This species is the most massive of our deep-sea corals, the next to it in that respect being perhaps *Stylaster erubescens*.

DISTICHOPORA Lamk.

Distichopora sulcata Pourt.

Distichopora sulcata Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate IV., fig. 14; and Plate VII., fig. 7.

Corallum dendroid, much compressed, somewhat rugose. Calicles sometimes isolated, but generally confluent and forming a deep furrow. Interseptal pores round, from eight to ten, surrounding the isolated calicles. Columella deep seated, hirsute, styliform. Color whitish.

Off Havana, in 270 fathoms.
In Mr. Arango's cabinet, in Havana, from the coast of Cuba, depth unknown.
Fragments brought up by the lead from 600 fathoms, lat. 31° 32′ N., long 78° 20′ W.

Distichopora foliacea Pourt.

Distichopora foliacea Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate IV., figs. 12 and 13.

Corallum branching, flabellate, much compressed, finely striated and granulated. The calicles in a somewhat irregular row, a little on one side of the edge, which is sharp and finely serrated. One of the rows of lateral pores on the summits of the denticulations, the other not well defined, represented by scattered tuberculated pores. The plane towards which the calicles are situated is thickly studded with am-

pullæ, each of which has a small lateral opening. They are less numerous on the other surface. Columella deep seated, long, hirsute, in the shape of a pointed club. Color orange-pink. Height 4 to 5 cm., thickness 2 to 3 mm.

This species differs from the preceding by its smaller calicles, not placed in a furrow, irregular lateral pores, and serrated edge.*

Off Key West, in 100, 135, and 154 fathoms.
Off the Samboes, in 116, 135, and 147 fathoms.
Off Tennessee Reef, in 124 fathoms.
Off Sombrero Light, in 152, 183, and 262 fathoms.
Off Bahia Honda, in 176 fathoms.
Off Coffin's Patches, in 195 fathoms.

ERRINA Gray.

Errina carinata.

Heliopora carinata Pourt. Bull. Mus. Comp. Zoöl., No. 6.
Pliobothrus carinatus Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate VI., fig. 5.

Corallum branching, very slender. Calicles confined to one side of branches, round, without lip or trace of septa. Perforated tubercles prominent, continued downward in sharp ridges. Columella slender, elongated, hirsute, too deeply seated to be seen without a section.

Having but a very small specimen of this coral, the determination of it remained uncertain until a part was sacrificed for a section, when a view of the columella settled the question.

The branchlets are only a millimeter and less in diameter.

Off Havana, in 270 fathoms.

* There is in the Museum of Comparative Zoölogy a specimen of a third species of Distichopora of West Indian origin. It was received from St. Thomas, through Mr. Duchassaing, and appears to be undescribed. It has nearly cylindrical branches, flattened more or less near the ends. Calicles in a very flat furrow, rather crowded. Lateral pores more developed in one of the series than in the other, transversely elongated, on top, or down the side of small tubercles, thus forming an approach to the structure of Errina. Smaller branches studded with ampullæ, scattered ones on the main stem. Color white. I would propose for it the name of *Distichopora cervina*.

LEPIDOPORA Pourt.

Corallum finely branching; interseptal chambers separate from calicles, in the shape of slit tubercles; lip of calicle projecting as a scale over the calicle.

This genus combines the characters of Errina and Cryptohelia, having the raised lip of the latter and the separate interseptal chambers of the former.

Lepidopora glabra Pourt.

Errina glabra Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate VII., figs. 8 and 9.

Corallum flabellate, not coalescing; the older parts of the stem much thickened, faintly striated and granulated; a row of very small perforated tubercles on each side of the branches. Calicles very small, circular; when terminal, surrounded by a few interseptal pores, which become separated from the calicles in the subsequent growth and form the lateral perforated tubercles. The calicles on one face of the branchlets hid by a scale-like projection; calicles obsolete on larger branches. Columella styliform, hirsute, in a deep fossa. Ampullæ scarce and small, smooth. Color white. Height 5 to 7 cm., diameter of branchlets .7 to 1 mm., of main branches about 3 mm.

Off Havana, in 270 fathoms.

Lepidopora cochleata Pourt.

Errina cochleata Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate III., figs. 17, 18, and 19.

Corallum branching, flabellate, very slender, finely granulated and striated, studded with echinulate ampullæ. Calicles formed as in preceding species, but distinctly bilabiate when terminal, and covered by a large spoon-shaped lip when lateral. Perforated tubercles more distinct than in *L. glabra*.*

Height 2 cm., diameter of branchlets .3 to .4 mm.

Off Havana, in 270 fathoms; rarer than preceding.

* The Museum of Comparative Zoölogy possesses remarkably fine specimens of a third species of Lepidopora, sent from Fayal by Miss Dabney. From want of specimens of comparison, and relying on the very brief definition of *Errina aspera* Gray, they were labelled with that name, and cata-

Family EUPSAMMIDÆ M.-Edw. & H.

Eupsammineæ M.-Edw. & H. Hist. Nat. des Coral.

This group, a subfamily of the Madreporidæ, according to Milne-Edwards and Haime, ought to be entirely separated from that association and constituted as a family by itself, as the same authors had done in their earlier publications in the "Annales des Sciences Naturelles" and in the "British Fossil Corals." It is one of the most natural families of the corals, and its affinities are much closer to the Turbinolidæ (the polyps being very similar) than to the Madreporidæ, with which it is only allied by its perforated walls.

BALANOPHYLLIA Searles Wood.

Balanophyllia floridana Pourt.

Balanophyllia floridana Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate IV., figs. 5 and 6.

Corallum elongated, conical, straight, attached in younger stages and often through life; but frequently also becoming free, by covering up the small object (shell or fragment of shell), after the manner of Heteropsammia, or by becoming accidentally detached from it. No epitheca, wall porous, costate to the foot. Calicle rather deep, elliptical. Septa entire, slightly exsert, finely granulated, in six unequal systems of four cycles, with rudiments of the fifth in some of the systems. Columella flat and papillose. Polyp generally brick-red. Height 2 to 3 cm. Diameters of calicle 10 and 15 mm.

Off Sand Key, in 26 fathoms.
Off the Quicksands, in 34 fathoms.
Off Conch Reef, in 39 fathoms.
Off French Reef, in 45 fathoms.
Off Carysfort Reef, in 48 fathoms.
Off Pacific Reef, in 49 fathoms.
Off Carysfort Reef, in 63 fathoms.

logued in the same way in Bull. Mus. Comp. Zoöl., No. 3. Having since seen the original specimens of *Errina aspera* in the British Museum, I have been enabled to recognize the mistake. The Fayal specimens form large flabelliform expansions, of great elegance, resembling *Stylaster flabelliformis*. The species is very nearly allied to *Lepidohelia glabra*, from which it differs by its more crowded branchlets, larger and more numerous tubercles, not confined to the sides of the branches, and rough cœnenchyma. I would propose the name *Lepidopora Dabneyi* for this species, which I cannot find to be described. (See Plate VII., figs. 10 and 11.) The specimens are associated with *Caryophyllia cyathus*, growing from the thicker branches. The spread of the corallum is nearly a foot.

The youngest individuals observed have the shape of a truncated cone attached by the base. The wall is quite smooth, *imperforate*, and the septa, twelve in number, equal and not quite extending to the centre, where the rudiments of the columella are already visible. At this stage none of the family characters are displayed. The dimensions are then about 2 mm. in diameter at the base, 1.3 at the calicle, and .8 in height. The next step of development is the formation of costæ on the upward prolongation of the wall. They first appear in the shape of sharp points grouped about the origin of the septa. About the same time an opening appears on the border and rather outside of the calicle, opposite each of the secondary septa, which gradually widens inwards, dividing apparently the septum in two. The two borders of that opening become the tertiary septa, the secondary septum is gradually pushed inwards, and is replaced by a new one growing out on the same radius from the wall, and but loosely connected with the joined tertiaries and original secondary. In a vertical section of an adult specimen a row of perforations is seen to extend both on the old and the new part of the secondary septum at the lines of junction with the tertiaries. The interior part of the tertiary septum is now to all intents and purposes a palus, and the whole arrangement quite similar to that of Deltocyathus, for instance. At this stage the septa are rather exsert and jagged on the edge, and seen in profile the resemblance with Stephanophyllia is quite striking, not taking the attached condition into consideration.

As the growth proceeds, the point of junction of tertiaries and secondaries moves farther into the calicle, until it reaches the columella. At this period the older or internal part of the secondary septum has nearly or entirely disappeared, and the same process of growth goes on with the septa of the fourth cycle, which become joined to those of the third.

One or two specimens show a coalescence of two individuals growing in a crowded position.

Although this species is generally destitute of epitheca, I hesitate in separating from it a form of which a number of specimens were obtained in 68 fathoms off the Tortugas. These were almost cylindrical, covered nearly to the calicle by a thin wrinkled epitheca, through which the costæ can be distinguished; the calicle contracted. All except a few young ones were dead, and have all the appearance of having been killed by being gradually covered with mud, as the calicle has mostly grown smaller and become stunted until definitively smothered. Having seen none of this form of a healthy growth, I am inclined to believe that they belong to *Balanophyllia floridana*, modified by external circumstances.

THECOPSAMMIA Pourt.

Corallum simple, attached, without costæ, or only rudimentary ones on the peduncle, covered with a complete epitheca. This genus is intermediate between Balanophyllia and Heteropsammia; like the latter, it is destitute of distinct costæ, but has an epitheca like some of the Balanophylliæ, more developed indeed than in any other representative of the family.

Thecopsammia tintinnabulum Pourt.

Thecopsammia tintinnabulum Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate I., figs. 9 and 10.

Corallum subcylindrical, or almost hemispherical, with turbinate base and small, abruptly constricted peduncle. Wall thick, very porous and vermiculated. Epitheca well developed, seldom rising quite to the border of the calicle, its tissue penetrating the mural pores and solidifying the wall. Calicle slightly elliptical, moderately deep. Septa in six unequal systems and four cycles, entire, thin, not exsert, with fine granulations; those of the fourth and fifth order scarcely bent towards those of the third, and not connected with the latter and with each other. The septa of the first and second order connected with the columella. The two opposite systems on the longer side of the calicle always incomplete in one of their halves, and one or two of the other systems also incomplete in the same manner. The columella papillose and porous, sometimes sublamellose, and forming three distinct masses in the adult, the middle one being largest.

Height 1.5 to 2 cm. Diameters 1.2 and 1.4 cm.; the average size is rather less.

The living polyp is of a handsome pinkish-orange color; the mouth oblong, and surrounded by rather numerous conical tentacles.

Off Key West, in 120 fathoms.
Off Key West, in 125 fathoms.
Off Key West, in 135 fathoms.
Off Key West, in 138 fathoms.
Off Marquesas, in 140 fathoms.
Off Key West, in 154 fathoms.

Thecopsammia socialis Pourt.

Thecopsammia socialis Pourt. Bull. Mus Comp. Zoöl., No. 7.

Plate II., figs. 9 and 10.

Corallum turbinate, rather long conical, with a thick, not much constricted peduncle. Wall and epitheca as in preceding species, but obscure traces of costæ can sometimes be seen through the epitheca near the peduncle. Calicle elliptical, moderately deep. Septa entire, smooth, crowded, not exsert, thick near the wall. Six unequal systems and five cycles. The convergence of the septa of the fourth cycle to meet in front of the tertiaries generally plainly visible from outside. The septa of the fifth cycle are developed in old specimens only, and then in few of the systems; but they soon become very large and encircle the two preceding cycles. The tertiaries remain smallest of all. The columella is papillose and porous, but more compact than in the preceding species, and nearly always forms three distinct masses, of which the middle one is largest.

This species often forms clusters, several individuals being united by their bases.

Height about 2 cm., diameter of calicle about 13 mm.

Off Coffin's Patches, in 195 fathoms.
Off Sombrero Lighthouse, in 262 fathoms.

This species, according to Dr. Duncan, has also been found by the "Porcupine" Expedition, in 345 and 363 fathoms, in the seas north of Scotland. The specimens were more developed than those from Florida, and rather variable, since Dr. Duncan distinguished three varieties. There is a considerable range of variation also in the Florida specimens. I have found in some cases, since the first description was written, the traces of costæ which had been noticed in some of the European specimens. The epitheca is particularly subject to variation, sometimes extending to the edge of the calicle, sometimes confined to the lowest parts of the peduncle. A specimen of the latter category shows distinct granular costæ in the bare part of the peduncle.

DENDROPHYLLIA Blainv.

Dendrophyllia cornucopia Pourt.

Plate V., figs. 7 and 8.

Corallum elongated, conical, generally curved, budding irregularly at various heights and on all sides. The younger corallites, remaining much smaller than the parent stock, implanted at right angles, afterwards curved upwards, but irregularly. Costæ distinct, but not prominent, finely porous. Sometimes a very rudimentary epitheca. Calicle elliptical, fossa rather deep. Septa thin, finely granulated, serrated inside of calicle, entire above, in six systems and four cycles in all the systems, the fifth in some of the quarter-systems adjoining the primaries. Columella large, densely spongy, elongated, and slightly convex.

Height of largest specimen 10 cm. Greater diameter of calicle 18 mm., lesser 16 mm. The younger ones budding out are not more than 6 mm. in diameter in any of the specimens.

A specimen has thirty-two buds, the largest has eighteen, smaller ones have none.

The polyp is of a deep maroon color, darkest on the disk, lighter on the wall.

Off Key West, in 120 and 125 fathoms.

A specimen of Dendrophyllia, rather incomplete, in the collection of Mr. R. Arango, in Havana, appears to be *D. cornigera* of which the Museum of Comparative Zoölogy possesses numerous specimens from Fayal. It differs from our species by the large size of the buds, which rapidly equal the parent stock. They are also usually confined to two sides of the main stock.

Dendrophyllia cyathoides Pourt.

Plate I., figs. 8 and 9.

Corallum broadly attached, elongated, branching irregularly and apparently only a few times, generally widened at the calicle. Costæ distinct to the base, in part veiled by a rudimentary epitheca, but prominent and serrate near the calicle, and continuous with the septa, which are thin, granulate, rounded, finely serrate, more exsert than in any other species of the genus, in six systems and four cycles, mostly

quite regular. Columella elongated, convex, composed of transverse or irregular twisted lamellæ.

Height 2 to 3 cm. Diameter of calicle about 1 cm.

Off Havana, in 270 fathoms.

Family FUNGIDÆ Dana.

This family has few representatives in the Atlantic basin, and most of them belong to the subfamily of Lophoserinæ M.-Edw. & H. In the littoral and reef zone all the species are compound; from deep water the dredge has brought up three small, simple species, the first simple Fungidæ found in these seas.

Fungia symmetrica Pourt.

Plate VII., figs. 5 and 6.

Corallum circular, plano-convex. Wall perfectly plane, with very small convex umbilicus in the middle, very little perforated. Costæ distinct to the centre; corresponding to the septa, finely spinous and granulated, particularly towards the border, subequal, primaries and secondaries slightly larger. Septa subequal, spinous, larger ones somewhat lobed, in six regular systems and four complete cycles. The septa of the fourth cycle connected by their inner edge with those of the third, and the latter with those of the second; the points of connection sometimes expanded into a kind of membrane. The primary septa reach the centre without lateral connection. Columella rudimentary, sometimes covered with a membranous expansion, through which some of the spines project. The synapticules are large, rather deeply seated, and correspond to each other in the contiguous chambers, so as to form from four to six more or less regular concentric circles.

Diameter of larger specimen 1 cm., of smaller 7 mm.

Off Cojima, Cuba, in 450 fathoms.
Off Carysfort Reef, in 350 fathoms.

This coral resembles *Cycloseris hexagonalis* very much, but the perforations of the wall and the echinulated costæ separate it apparently from that genus. I am, however, inclined to doubt the generic value of those characters, as the younger of the two specimens shows them in so small a degree that they would generally escape notice. If found in a sea where larger Fungiæ were common, these specimens would naturally be considered as the young of one of them.

Diaseris pusilla Pourt.

Diaseris pusilla Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate II., figs. 6, 7, and 8.

Corallum subelliptical, very fragile. Wall flat or slightly concave, imperforate, very thin, finely costate. Costæ thin, alternately large and small, finely dentate. The base shows the traces of lobes joined together, often very imperfectly. Septa strongly dentate, laciniate, and perforate, marked with strong ridges and furrows, connected with each other by synapticula near the base (see Plate II., fig. 7). Five cycles of septa and six unequal systems, one or two being generally incomplete. The primary septa more lobed and much higher than the others; those of the lower cycles tending to unite with those of the cycles preceding them. Fossa oblong, well marked. Columella rudimentary in the shape of a narrow ridge.

Color of the polyp dark brown, tentacles simple, conical, rather long.

Diameter of largest specimen 16 mm.

Off Sand Key, in 119 fathoms.
Off Sand Key, in 120 fathoms.
Off Sand Key, in 135 fathoms.
Off Alligator Reef, in 147 fathoms.
Off Tennessee Reef, in 174 fathoms.
Off Alligator Reef, in 156 fathoms.
Off Alligator Reef, in 189 fathoms.

Diaseris crispa Pourt.

Plate V., figs. 1 and 2.

Corallum irregularly circular, formed of loosely joined lobes. Wall very thin, horizontal, indistinctly costate, but deeply furrowed in the junction of the lobes. A few minut scatteered spines and granules, particularly at the edge of the lobes. Septa subequal, not laciniate, serrate; the teeth equal and flattened transversely to the septa, thus giving to the surface a densely crispate appearance. Systems unequal on account of the irregular mode of growth, four cycles and seldom rudiments of a fifth. Primary and secondary septa equal, those of the two next cycles slightly smaller. All the septa but those of the fourth cycle reach the centre, the latter connect with the tertiaries about half-way. Fossa moderately concave, no columella, the wall in the centre sometimes eroded.

Dimensions slightly smaller than those of *Diaseris pusilla*. Both species are generally found together in some abundance, but perfect specimens are rare, on account of their great brittleness. Many specimens have evidently been broken and mended as the one figured in Plate V., fig. 2. Such deformities in other groups of corals have been described as genera, as, for instance, Ecmesus by Philippi, and Hemicyathus by Seguenza.

MYCEDIUM Oken.

Mycedium fragile Dana.

This species was obtained in considerable quantities in the two localities named below. The greater number of the specimens were dead, but an interesting series of young ones of all ages were obtained (see Bulletin Mus. Comp. Zoöl., No. 13, by Professor Agassiz). It is not uncommon in less depth, though not often found on the reef.

In looking over the materials in the Museum, for the determination of this coral, it has become very apparent that a revision of the group is very urgent, and that probably a large number of species, and even some genera, are based on very insufficient characters and ought to be united. In fact, several of the specimens obtained by me in the same dredgeful, if seen separately from different localities, would unhesitatingly be pronounced different species; whilst being put on guard by the association, a closer examination shows that the characters vary considerably, even in different parts of the same corallum. Such are the costal striæ, which may be subequal, or alternately large and small; the calicles, which may be flat or raised, isolated or in rows, columella present or absent, etc.

In this connection it may be remarked that *Mycedium fragile*, which Milne-Edwards and Haime think may be closely allied to *Agaricia undata*, has really no resemblance to that species at all. The latter is found on the coast of Cuba (cabinet of Mr. R. Arango, in Havana), but not in Florida, as far as I am aware.

Off Tortugas, in 36 and 43 fathoms.

Order RUGOSA M.-Edw. & H.

The section of Rugosa was established by Milne-Edwards and Haime for a large number of fossil corals, all of an older age than the carboniferous formation, and particularly abundant in the palæozoic ages. Their chief characteristic, according to those authors, is the development of the septa proceeding from four primary ones, whilst in all of the living corals the primary number is six. In addition, the chambers are closed inferiorly by an abundant endotheca, often assuming the shape of floors; but this character is not found in all the families of the section, though certainly in the greater number. Mr. R. Ludwig has shown (H. v. Meyer's *Palæontographica*, Vols. X. and XIV.) that the tetrameral arrangement claimed for the Rugosa is only apparent, there being originally six primary septa; but that the further development in each system is asymmetrical; and that two of the systems remain generally undeveloped.

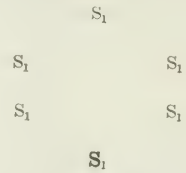
I had, before having knowledge of Ludwig's researches, come substantially to the same conclusions by the examination of *Lophophyllum proliferum* Edw. & H., from the carboniferous formation, a form very suitable for that study. As I find my mode of explaining the development slightly different from Ludwig's, it may not be too much out of place to mention it here in a few words.

When the youngest stage of the coral is examined by cutting through the tip of the conical *Lophophyllum proliferum*, six primary septa and six interseptal chambers are found, placed symmetrically on two sides of a vertical plane, and unequally developed. This plane would pass through two of the primary septa, of which one may be called anterior and the other posterior, for convenience merely. The two lateral systems (which would be divided by a plane at right angles to the antero-posterior plane) are at the earliest stages larger than the others. In progress of growth the anterior primary system is checked in its development, and the two adjacent chambers partly coalesce to form the so-called *septal fossa*. The posterior primary septum is fully developed, and joins the columella (when there is one). The systems between this and the two adjacent primaries do not become subdivided again, so that these three septa remain close together; according to Ludwig, they subdivide to a small extent in some genera. Thus, of the six primary interseptal chambers, the two posterior ones remain undivided. The four other ones are each divided by a secondary septum joining the primary; of the two half-systems thus formed in each, the anterior one is again divided by a tertiary septum joining the secondary; next the anterior quarter-systems are divided, and so on. The four lateral

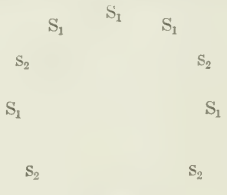
primary septa thus assume gradually the shape of unsymmetrically dichotomous branches.*

The following notation may render the idea more plainly.

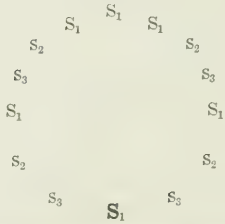
The primary septa can be represented thus: —



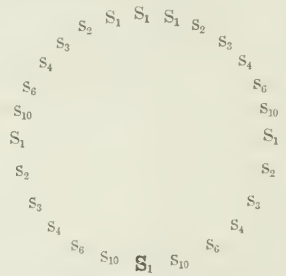
The upper and lower being in the longer axis, the lower **S** being the one in the septal fossa. The next step of development will be: —



And further: —



Still continuing with Milne-Edwards and Haime's system of notation, we would have, after a few more steps: —



* A somewhat similar unsymmetrical development of the systems has been observed in some of the Medusæ; for instance, *Willia*, *Proboscidactyla*. See Agassiz, Contr. Nat. Hist. U. S., Vol. IV.; and A. Agassiz, Ill. Cat. Mus. Comp. Zoöl., No. II.

For the sake of symmetry, the number of septa has been made equal in all the systems in these diagrams, which is seldom the case.

Sometimes a small rudimentary septum is seen in each half of the septal fossa on the sides of **S**.

Numerous illustrative figures will be found in the plates accompanying Ludwig's paper.*

Mr. A. Kunth (*Zeitschr. der Deutsch. Geol. Ges.*, XXI., Heft 3) has also examined the law of growth of the Rugosa, chiefly by the consideration of the successive development of the costæ. He still adheres to the tetrameral primary division, from want of having examined individuals of very young age, and hence great simplicity. The papers of Römer and of Lindström I have had no opportunity to examine.

In the Bulletin of the Museum of Comparative Zoölogy, No. 7, I referred to the Rugosa, a new genus and species, though with some doubt. I hoped to be able to procure more numerous specimens, particularly as the single one on which the determination rested was not quite normally developed. In this I have been disappointed, so that the position of the genus in the system must still remain provisional. The chief ground for placing it among the Rugosa is its general appearance, its smooth ungranulated septa, not resolvable into the regular hexameral arrangement, but on the other hand difficult also to refer to the modified hexameral system just exposed.

HAPLOPHYLLIA Pourt.

Haplophyllia Pourt. Bull Mus. Comp. Zoöl., No. 7.

Corallum simple, fixed by a broad base, covered with a thick epitheca; columella styliform, strong, very thick at the base. Interseptal chambers deep, uninterrupted by tabulæ or dissepiments, but filling up solid at the bottom.

The nearest known form to Haplophyllia which I have been able to find is *Calophyllum profundum* Germ. (Geinitz) (*Astrocyathus Geinitzii* Ludw.),† which, however, lacks a columella. It is fossil in the Dyas.

* There are several points of resemblance in the mode of division of the calicle in the Pocilloporæ and in the Rugosa, which would warrant a closer examination; such are the bilateral symmetry combined with a more or less marked antero-posterior asymmetry, the shallow calicles, the tabulæ, etc. The order of succession of the septa in the Pocilloporæ is not known.

† Ludwig has formed new generic names for nearly all the fossil corals, to adapt them to his classification; such a proceeding can only introduce confusion, particularly as his arrangement is quite artificial. A table of double entry is no doubt very convenient, but unfortunately the organized beings were not created on such a plan.

Haplophyllia paradoxa Pourt.

Plate II., figs. 11, 12, and 13.

Corallum subcylindrical, short, fixed by a broad base; epitheca thick, wrinkled, reaching above the border of the calicle, and forming around the latter several concentric circles, as if formed of several layers. Calicle circular, fossa deep. Septa smooth, without granulations or perforations, not reaching the border of the calicle, with smooth enamelled surface, like the other internal parts of the calicle. Columella formed of two smooth conical processes, very thick at the base and tending to fill up the chambers. Eight septa larger and connecting with the columella, alternating with smaller ones, which touch the columella at a much lower level. A further cycle is indicated by mere rudiments in some of the chambers. In the specimen there are irregularities in two of the systems or half-systems, one of which is closed by a horizontal plate, probably to exclude a parasitic intruder.

Polyp scarlet, greenish in alcohol, with about sixteen rather long tentacles, bluntly tuberculated at the tip.

Height 1.5 cm., diameter 1.2 cm.

Off Bahia Honda, Florida, in 324 fathoms.

Suborder ANTIPATHARIA M.-Edw. & Haime.

This suborder, with one single family, the Antipathidæ, constitutes a very natural and homogenous group, if we remove from it the genus Gerardia of Lacaze-Duthiers, which has no other relationship with the other genera than the property of secreting a horny polypidom. The polyps of a Gerardia differ in no particular from those of most of the Zoanthidæ in the arrangement, number, or shape of the tentacles; they even agree with that group in the habit of incrusting the derm with small foreign bodies. Hence it would be quite proper to place *Gerardia Lamarcki*, Lacaze-Duthiers, the only species known, among the Zoanthidæ, as type of a subfamily.

The subdivision of the Antipathidæ into genera by Blainville, Gray, and Milne-Edwards is based entirely on the solid parts. The few species of which I have had the opportunity of examining the polyps, all belong to the genus Antipathes proper, according to the characteristics heretofore adopted. It has seemed to me, however, that two distinct types of polyps could be distinguished, the one well circum-

scribed, flower-shaped, symmetrically radiate, with long tentacles; the other so elongated longitudinally that the radiate shape is quite indistinct, the six tentacles being disposed in pairs at some distance from each other. Unfortunately the number of species examined is too small to allow of basing any attempt at classification on those characters, which furthermore seem to bear no connection with the general shape of the corallum.

ANTIPATHES Pallas.

Antipathes tetrasticha Pourt.

Antipathes tetrasticha Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Corallum with simple stem, pinnate; branchlets alternate and generally double, two branchlets starting from the same point at an acute angle, thus forming four rows, two on each side of the main stem. In some specimens few of the branchlets are double, in others nearly all. The branchlets are moderately beset with short, somewhat blunt, triangular spines. No swellings, as in *A. humilis* and *A. filix*.

Polyps small, very much elongated, with the tentacles short and blunt, placed in pairs, so that in a branchlet or pinnule the lower side appears fringed with tentacles placed in pairs, and it requires some attention to distinguish the single polyps by the position of the mouth. They are all of one size on the pinnules, but there is generally a somewhat larger polyp on the main stem between the successive pinnules.

Total height 7 cm., length of pinnules 3 to 4 cm.

Off Sand Key, in 120 and 125 fathoms.

Duchassaing and Michelotti have described very briefly, under the name of *A. americana*, a pinnate species with simple stem, but the pinnules are described as dichotomizing rather frequently, which is never the case in ours.

Antipathes dissecta Duch. & Mich.

The very scanty description given of this species in *Supplement au Mémoire sur les Coralliaires*, etc., leaves some doubt as to the correct identification of my specimens, of which it is therefore not superfluous to give a fuller description.

Corallum large, irregularly branching into long, crooked arms, of more or less elliptical section. Ultimate branchlets or pinnules few in number, alternate and very loosely pinnate, without swellings. (Du-

chassaing and Michellotti had evidently specimens with dried polyps before them, which give to the branchlets the appearance described by them.) Spines confined only to the smaller branches and branchlets, few, small, and rounded, thus having under the microscope a nipple-shape appearance in profile, though flattened longitudinally.

Polyp large, resembling in their proportions those of *A. arborea*, as represented by Dana. They are all on one side of the branchlets (not the upper or lower), and generally the row is composed of alternately large and small polyps. The mouth surmounts a tubercle and is elongated transversely to the branch, as has been observed by Lacaze-Duthiers in other species of the genus. The tentacles are elongated, conical, and do not appear susceptible of much contraction, but can be curled up over the mouth. They are never found contracted into small knobs, as in some species hereafter described. The largest specimen obtained is one meter high, the main stem being 2 cm. in diameter. Pinnules 3 or 4 cm. long.

Off Alligator Reef, in 110 fathoms.
Off Sand Key, in 125 fathoms.
Off Coffin's Patches, in 195 fathoms.
Off Bahia Honda, in 324 fathoms.

Antipathes filix Pourt.

Antipathes filix Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Main stem simple, pinnate; the pinnules setting off nearly at right angles, rather short, alternate, covered with spines or short, stiff hairs, and showing a succession of slight swellings and contractions. Soft parts not observed.

Height about 7 cm.

Every specimen obtained served as support to the tube of an Annelid.*

Off Havana, in 270 fathoms.

Antipathes humilis Pourt.

Antipathes humilis Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Corallum flabellate, irregularly dichotomous, spreading more laterally than vertically, hirsute, the spines being slender and longer than the diameter of the branchlets, which are alternately swollen and con-

* The specimens having been sent to Professor Ehlers with the collection of Annelids, I have been prevented from comparing the polyps with those of the other species since obtained.

tracted. Polyps all on the same side of the flabellum, on the swellings of the branchlets, about one diameter apart. Tentacles very short, when contracted forming small knobs shorter than the spines, and placed in two rows, the mouth appearing between the middle pair.

The spines surrounding the polyp are larger than those in other parts of the branches; the largest appear inside the polyp, in the spaces between the tentacles. Mouth surmounting a tubercle surrounded by about twelve papillæ in a close circle; a second circle of papillæ on the peristome just inside of the tentacles; similar ones are scattered on the whole surface of the sarcosome.

Height 10 to 12 cm., spread 12 to 14 cm.

Off Havana, in 270 fathoms.

Fragments of another subflabellate Antipathes were brought up from 68 fathoms, west of Tortugas, different from *A. humilis*. There is not enough of it, however, to give a full description.

Antipathes lenta Pourt.

Mode of branching unknown. Pinnules very long and slender, like thin horse-hair, not in a regular pinnate arrangement; spines in number intermediate between *A. larix* and *A. subpinnata*, as figured by Lacaze-Duthiers, but somewhat longer, and straighter than in either.

Polyps of the same type than those of *A. dissecta*, but very much smaller, and appear more distant from each other; the longitudinal and transverse diameters are more disproportionate than in the preceding species, and the tentacles show more the tendency of arranging themselves in two parallel rows. The alternance of large and small polyps, though not very regular, is quite noticeable, and the disproportion of size of the two kinds very great. Only a few branchlets of this species were obtained, some of them 10 to 12 centimeters long, without much diminution of diameter.

Off Carysfort Reef, in 35 fathoms.
Off Tortugas, in 37 fathoms.

Family ACTINIDÆ M.-Edw. & Haime.

This family is represented by five species in our deep waters, namely, two Actiniæ, two Palythoæ, and one Ilyanthus. The almost insuperable difficulty of determining satisfactorily animals of this family from much contracted alcoholic specimens will prevent anything more than a simple notice, without attempt at naming them.

The larger Actinia, milk-white, with orange disc and tentacles, is found sparingly between 120 and 195 fathoms. The smaller appears to live unattached in sand, in about 90 fathoms: it is of brownish color, and disk-shaped when contracted.

A Palythoa not very different from *P. acalhida* Lamx. from the Florida coast is quite common, ranging from 35 to 287 fathoms, attached in considerable numbers to foreign bodies.

A large black Palythoa appears to live solitary in 42 fathoms.

One specimen of an Hyanthus was found in 124 fathoms, off Tortugas.

A disk-shaped Actinian covered with sand was obtained in 85 fathoms off Tennessee Reef, and in 91 and 93 fathoms off Bahia Honda and off the Samboes. It probably belongs to the new genus Ammodiscus Carpenter, dredged off the coast of Portugal. It is not destitute of tentacles in my specimens.

Order ACALEPHÆ.

Suborder HYDROIDEÆ Johnston.

MILLEPORIDÆ Agass.

Milleporidæ M.-Edw. & H.

Since Professor Agassiz's first announcement of the affinities of the Millepores with the hydroid polyps, it does not appear that new observations have been made on the subject, although twenty years have elapsed since. The polyps of Millepora are very difficult to observe, not only on account of their very small size, but also because they require peculiar care in collecting, being killed by the shortest contact with air. If they have finally expanded, after much patient waiting on the part of the observer, the least shock to the vessel, or attempt to bring the specimen in a convenient position, is sufficient to make the polyps contract instantaneously and often finally. I have succeeded but once in having a good view of one of the larger polyps of *Millepora alcicornis*, in company with Professor Agassiz. It differed from the figure in the "Contributions to the Natural History of the United States," Vol. III., Plate XV., fig. 6, in being comparatively shorter, and having larger tentacles or rather tentacular masses studded with lasso cells, five in number instead of four. The mouth was not seen very

distinctly, but appeared to be a transverse slit in the middle of the disk. It remained expanded but a short time.

It is almost unnecessary to add, after these remarks, that the deep-sea Milleporidæ afforded no opportunity to observe their polyps.

PLIOBOTHRUS Pourt.

Corallum branching; tissue more compact than in Millepora; larger pores scarcer, smooth, without any rudiments of septa; smaller pores tubulated, cœnenchyma finely porous, the pores linear and arranged in rows.

Pliobothrus symmetricus Pourt.

Pliobothrus symmetricus Pourt. Bull. Mus. Comp. Zoöl., No. 7.

Plate IV., figs. 7 and 8.

Corallum ramose, rising from an incrusting base and a short trunk, branching into a more or less regular flabellum. Branches cylindrical, flattened, and slightly expanded at the tip. The tendency in branching is towards considerable symmetry between the two halves of the flabellum. Three kinds of pores; very small, linear, over the whole cœnenchyma; larger tubulated, with very minute aperture when unbroken, and larger round or oval ones scattered irregularly. Internal structure coarsely porous; the larger pores expanding at the bottom into a flat cavity communicating laterally with other canals. Tabulæ very thick and not numerous; the interposed chambers soon filling up. Occasional round cavities are found in the centre of the branch, filled with a yolk-like substance contained in a membrane.

Color gray. Height 5 to 7 cm. Diameter of branches about 5 mm. Diameter of larger pores .4 to .5 mm.

Off American Shoal, in 98 fathoms.
Off Alligator Reef, in 118 fathoms.
Off Sand Key, in 123 fathoms.
Off the Samboes, in 125 fathoms.
Off Sand Key, in 135 fathoms.
Off Sand Key, in 143 fathoms.
Off Sand Key, in 154 fathoms.

It has also been found, according to Dr. Duncan, in from 500 to 600 fathoms, in the cold area to the northward of the British Islands by the "Porcupine" Expedition.

Pliobothrus tubulatus Pourt.

Heliopora tubulata Pourt. Bull. Mus. Comp. Zoöl., No. 6.

Plate IV., fig. 9.

Branches not much divided, cylindrical; the tubulated pores very prominent and slender, giving to the coral a hirsute appearance. The internal structure appears to be of the same pattern as in the preceding species.

Height, incomplete, 2.5 cm. Diameter of branches about 3 mm.

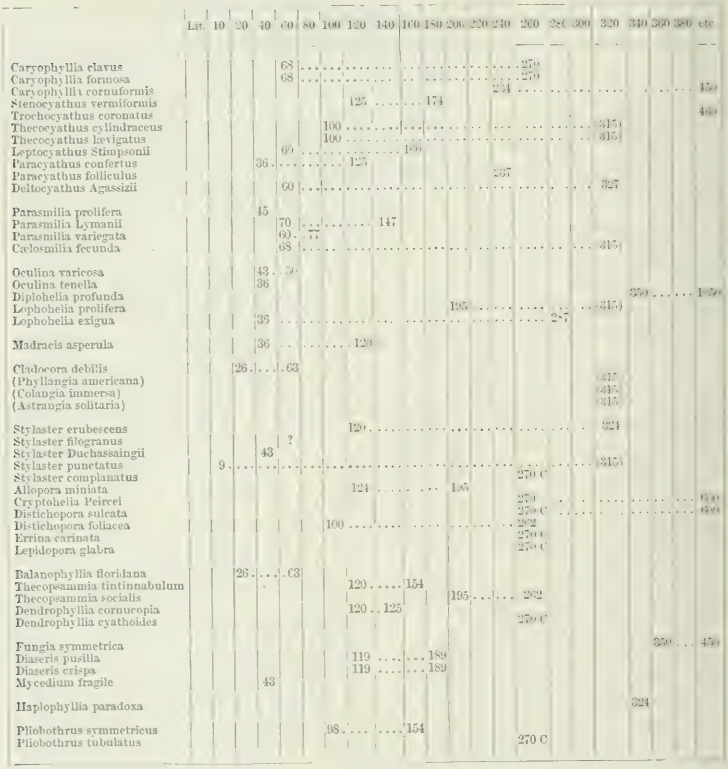
Off Havana, in 270 fathoms.

GEOGRAPHICAL DISTRIBUTION.

We are as yet too little acquainted with the deep-sea fauna of other parts of the world to be able to trace the distribution of our corals. The only parts of the sea bottom well explored up to the present time, besides the Florida Straits, are along the coasts of Europe from Norway to the Straits of Gibraltar and the Mediterranean. The comparison of the Echinoderms of the two regions has revealed quite a number of species common to both (see Bull. Mus. Com. Zoöl., Nos. 9 to 12). But this is not the case with the corals; Dr. P. M. Duncan, in his paper on the Madreporaria dredged up in the expedition of H. M. S. "Porcupine," enumerates four species common to the northern seas of Europe and the Florida Straits, namely, *Diplohelia profunda*, *Lophohelia prolifera*, *Thecopsammia socialis* and *Pliobothrus symmetricus*. *Lophohelia prolifera* is found also in the Mediterranean. To these can be added *Caryophyllia clavus*, which has about the same range as the last. *Madracis asperula* and *Cladocora debilis* are found in Florida and Madeira, but they cannot properly be called deep-sea corals.

The observations on the coast of Cuba are so few, that no definitive conclusions can be drawn as to the differences between the faunæ of the two sides of the straits, but I have found no reason yet for doubting the statement made in a former paper, that certain species are found only on the Cuban side; for instance, *Stylaster complanatus*, *Distichopora sulcata*, *Errina carinata*, *Lepidopora glabra*, *Dendrophyllia cyathoides*, and *Pliobothrus tubulatus*. Examples from other classes can also be found, which appear never to have crossed the Gulf Stream and the straits; such is the Pentacrinus.

TABLE OF DISTRIBUTION ACCORDING TO DEPTH IN FATHOMS.


Lit. 10 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380 etc
Caryophyllia clavus 68 270
Caryophyllia formosa 68 270
Caryophyllia cornuformis 254 450
Stenocyathus vermiformis 125 174
Trochocyathus coronatus 450
Thecocyathus cylindraceus 100 315
Thecocyathus lævigatus 100 315
Leptocyathus Stimpsonii 60 100
Paracyathus confertus 36 125
Paracyathus folliculus 237
Deltocyathus Agassizii 60 327
Parasmilia prolifera 45
Parasmilia Lymanii 70 147
Parasmilia variegata 60
Cœlosmilia fecunda 68 315
Oculina varicosa 43
Oculina tenella 36
Diplohelia profunda 370 450
Lophohelia prolifera 195 315
Lophohelia exigua 36 287
Madracis asperula 36 120
Cladocora debilis 26 63
(Phyllangia americana) 315
(Colangia immersa) 315
(Astrangia solitaria) 315
Stylaster erubescens 120 324
Stylaster filogranus ?
Stylaster Duchassaingii 43
Stylaster punctatus 9 315
Stylaster complanatus 270 C
Allopora miniata 124 195 270 630
Cryptohelia Peircei 270 C 630
Distichopora sulcata
Distichopora foliacea 100 282
Errina carinata 270 C
Lepidopora glabra 270 C
Balanophyllia floridana 26 63
Thecopsammia tintinnabulum 120 154
Thecopsammia socialis 195 282
Dendrophyllia cornucopia 120 125
Dendrophyllia cyathoides 270 C
Fungia symmetrica 350 450
Diaseris pusilla 119 189
Diaseris crispa 119 189
Mycedium fragile 43
Haplophyllia paradoxa 324
Pliobothrus symmetricus 98 154
Pliobothrus tubulatus 270 C

N. B. — The letter C added to the figures indicating the depth means that the species was found exclusively on the coast of Cuba. A parenthesis indicates that the specimens were probably carried to the locality by currents. Names in parentheses are littoral species.

BATHYMETRICAL DISTRIBUTION.

The bathymetrical distribution is exhibited on the accompanying table. From it we can readily separate the species found in depths less than 100 fathoms, which inhabit the region of *débris* between the reef and the rocky plateau beginning at the above depth. They are the following: —

Parasmilia prolifera.
Parasmilia variegata.
Oculina varicosa (dead fragments only).
Oculina tenella.
Cladocora debilis.
Stylaster Duchassaingii.
Balanophyllia floridana.
Mycedium fragile (found also on the reef).

A few others extend from the same region into the next or rocky one; but as the limit is not a sharp one, it is difficult to say if they really belong to the one or the other, or were gathered by the dredge from patches of rock in the muddy bottom, or muddy patches in the rocky bottom.

They are: —

Caryophyllia clavus.
Caryophyllia formosa (decidedly on rock on Cuban coast).
Leptocyathus Stimpsonii.
Deltocyathus Agassizii.
Parasmilia Lymanii.
Cœlosmilia fecunda.
Lophohelia exigua.
Madracis asperula.
Stylaster punctatus (see remarks in description).
Pliobothrus symmetricus.

The characteristic species of the rocky bottom, at greater depths than 100 fathoms, are: —

Stenocyathus vermiformis.
Thecocyathus cylindraceus.

Thecocyathus lævigatus.
Lophohelia prolifera.
Stylaster erubescens.
Allopora miniata.
Distichopora foliacea.
Thecopsammia tintinnabulum.
Thecopsammia socialis.
Dendrophyllia cornucopia.
Dendrophyllia cyathoides.
Diaseris pusilla.
Diaseris crispa.
Pliobothrus symmetricus.
Pliobothrus tubulatus.

In the Globigerina mud we find only the following species: —

Caryophyllia cornuformis (living).
Paracyathus folliculus (dead).
Diplohelia profunda (dead).
Fungia symmetrica (dead).
Haplophyllia paradoxa (living).

On the whole the differences between these different regions are not very great, at least as far as family and generic characters go. But the differences from the nearest reef fauna are, as might be expected, very striking. No Astræidæ, no Madreporidæ (excluding the Eupsammidæ), the most abundant families in species and in individuals on the West Indian reefs, extend to any considerable depth. The families having apparently the greatest range in depth are the Oculinidæ, the Stylasteridæ, and the Milleporidæ.

Simple corals which form such a large proportion of the deep-sea fauna are not represented at all in the Floridian reef fauna; some species are described from the West Indies, but without indications of depth.

The specimens of soundings brought up by the lead from the Gulf Stream farther north contain frequently small fragments of corals, of which the following have been determined: —

Cryptohelia Peircei, lat. 31° 32′ N., long. 78° 20′ W., 600 fathoms.
Distichopora foliacea, lat. 31° 32′ N., long. 78° 20′ W., 600 fathoms.
Stylaster erubescens, lat. 31° 32′ N., long. 78° 20′ W., 600 fathoms.
Lepidopora glabra, lat. 31° 32′ N., long. 78° 20′ W., 600 fathoms.
Diplohelia profunda, lat. 30° 1½′ N., long. 79° 35½′ W., 530 fathoms.
Caryophyllia formosa, lat. 30° 1½′ N., long. 79° 35½′ 530 fathoms.
Stylaster erubescens, lat. 29° 48′ N., long. 79° 17′ W., 450 fathoms.
Lepidopora glabra, lat. 29° 48′ N., long. 79° 17′ W., 450 fathoms.
Diplohelia profunda, lat. 28° 53½′ N., long. 79° 33¾′ W., 410 fathoms.

These localities are all in or near the axis of the Gulf Stream, be-

tween the latitudes of Cape Canaveral and Savannah. The specimens are all broken and worn and associated with Foraminifera remarkably clean and free from mud. The indications are that a current sweeps over the bottom in a direction from south to north: in other words, the Gulf Stream extends to the bottom at least as far north as the highest latitude mentioned, and is not underlaid by a cold arctic current running in opposite direction, as has sometimes been assumed to account for the low temperature at the bottom. We know that the corals enumerated above (with the exception of *Diplohelia profunda*, which I have never found alive) live on the coast of Cuba and Florida in depths not less than 100 fathoms, and are thus out of reach of transportation by superficial agencies.

A possible nearer habitat would be the northern extremity of the Bahama Banks, between latitudes 27° and 28°, and perhaps somewhat farther north on the extension of the banks which is known to exist on the eastern border of the Gulf Stream; yet even in this case the transportation would be in the same direction. We have positive evidence of the depth to which the current extends in the straits, in the experiment of Assistant H. Mitchell, United States Coast Survey, whose conclusion is, "*that the Gulf Stream has a nearly uniform velocity and constant course for a depth of six hundred fathoms, although its temperature varies in this depth* 40 *Fahrenheit.*" (See Report of the Superintendent United States Coast Survey for 1867, pp. 176–179.)

REEF CORALS.

The corals constituting the Florida Reefs, or growing in the shoaler waters of that region, belong to the West Indian Fauna, without exception. They have been made a special object of study by Professor Agassiz for many years, and this part of the catalogue was to have been written by him. But as the multiplicity of other labors has thus far prevented him from putting this project in execution, and as a long absence from the Museum will still further protract the delay, it has appeared preferable to add this list, with remarks from notes made by me in the field and in the Museum, so as to have as complete a view of the coral fauna of Florida as possible.

Professor Agassiz's future work will bear chiefly on the structure of the polyp as well as of the hard parts, and on the geological part taken by the different corals in the formation of the reefs and of the peninsula of Florida.

Family OCULINIDÆ Verrill.

OCULINA M.-Edw. & H.

Oculina Lamk. (pars).
Oculina Ehrbg. (pars).
Matrepora Oken.
Oculina Dana (pars.)

Oculina diffusa Lamk.

Non *Oculina varicosa* Lesueur, Dana.
Non *Oculina pallens* Ehrbg., Dana.

Very common. Low-water mark to fifteen fathoms.

Oculina varicosa Lesueur.

Madrepora mammillaris Ellis?
Oculina varicosa Dana.
Oculina Peticeri M.-Edw. & H.

As pointed out by Mr. Verrill (Bull. Mus. Comp. Zoöl., No. 3), this species is entirely different from *O. diffusa*, of which M.-Edwards and Haime had supposed it to be a synonyme. Lesueur's description and figure are quite insufficient to determine if he really had this species before him; it has been, in point of fact, first described by Dana.

It has not yet been found in Florida in a fully developed state, to my knowledge. I have referred to it some branchlets which I had at first described as *Oculina disticha* (see Deep-Sea Corals, p. 22), dredged off the Reef. The Museum possesses fine specimens from Bermuda; it has also from the same locality specimens of *Oculina pallens*, Ehrbg., Dana, which is certainly not synonymous with *O. diffusa*, as supposed by M.-Edwards and Haime.

Oculina robusta Pourt.

Corallum sparsely branching; trunk rather massive (3 to 4 cm. in diameter). Calicles numerous, about 3.5 mm. in diameter and about the same distance apart, with prominent border, forming more or less regular spiral lines. Three cycles; primary and secondary septa about equal, tertiaries but slightly smaller. Pali small, pointed, not very different from the columellar papillæ, which are very numerous. Costal striæ well marked, much curved, broad and flat, delicately granulated.

One specimen (No. 857) in the Museum was received from Dr. Holder at Tortugas, Florida, to whom the Museum is also indebted for a fine series of corals from that vicinity. I am informed by Mr. A. Agassiz that there is another fine specimen in the New York Free Academy, from the same locality.

Oculina arbuscula and *Oculina implicata*, Ag. Ms. (Verrill, Bull. Mus. Comp. Zoöl. No. 3) are not found in the reef region. The former is common on the coasts of North and South Carolina, and its northern limit is probably Cape Hatteras. The second is only known from specimens thrown up on the beaches of North Carolina, and has a semi-fossil appearance.

Family STYLOPHORIDÆ Pourt.

Pseudoculinæ M.-Edw. & H. Ann. Sci. Nat., 3e Sér., Vol. XIII., 1850.
Stylophorinæ M.-Edw. & H. Hist. Nat. Coral., 1857.

MADRACIS M.-Edw. & H.

Madracis decactis Verrill.

Astrea decactis Lyman. Proc. Bost. Soc. Nat. Hist., Vol. VI., 1857.

Found in depths ranging from 6 to 17 fathoms. Not abundant. (See remarks in Deep-Sea Corals.)

Family ASTRÆIDÆ Dana.

Subfamily EUSMILINÆ M.-Edw. & H.

EUSMILIA M.-Edw. & H.

Eusmilia fastigiata Edw. & H.

Seba, Pl. 109, fig. 1; Pl. 110, fig. 3; and Pl. 116, fig. 4?
Madrepora fastigiata Pallas Fig. 53.
Non *Madrepora fastigiata* Ellis & Sol. Pl. 33?*
Non *Madrepora capitata* Esper. Pl. 82 (copied from Ellis)?
Non *Caryophyllia fastigiata* Lamx. Pl. 33?
Madrepora fastigiata Esper. Pl. 8? and var. β, Pl. 8 A?
Euphyllia aspera Dana. Pl. 9, fig. 7.
Non *Mussa fastigiata* Dana. Based on Ellis's figure.
Eusmilia aspera Duch. & Mich. (They quote Dana's figure.)

This species is well characterized by its finely serrated costæ, which do not extend far down from the calicle. The septa of the cycle preceding the last have well-formed but very thin pali or paliform lobes, which are not found in the next species.

Rare. The Museum has only one small specimen found living at Looe Key, Florida Reef, and a larger one from Cumana.

* I have not seen any worn specimens with the septa forming such points as represented. The species cannot be made out satisfactorily.

Eusmilia alticostata M.-Edw. & H.

Several specimens in the Museum from Florida agree better with the description of this species than with the description and figure of *Eusmilia aspera* M.-Edw. & H. (not *Euphyllia aspera* Dana), of which I have no typical specimens for comparison. As suggested by M.-Edwards and Haime, this may be only a variety. The columella in our specimens is very little developed; the costæ thin, foliaceous, forming a succession of lobes, extending far down, very indistinctly or not at all serrate. The calicles are generally considerably smaller than in *Eusmilia fastigiata*. The differences thus appear to be more considerable than the short description of Milne-Edwards and Haime would suggest.

Florida Reef, rare; Agassiz, Pourtalès.

DICHOCŒNIA M.-Edw. & H.

Dichocœnia Stokesi M.-Edw. & H.

D. Stokesii M.-Edw. & H. Ann. Sc. Nat., 3e Sér., t. X., p. 307, Pl. 7, fig. 3, 1849.

The Museum has but three specimens of Dichocœnia from Florida, which present considerable differences among each other, particularly with regard to the intercalicinar surface, which in the larger specimen is entirely occupied by thick granular costæ, the calicles being much more crowded than in Milne-Edwards and Haime's figure. In the others, which are young specimens, these spaces are coarsely granular, with less distinct costæ. There is also considerable diversity in the development of the pali. They are all referred provisorily to the above species. A specimen from Hayti resembles the figure more closely.

It is quite difficult to make use of the descriptions and figures of the various species established by Duchassaing and Michelotti, which are mostly based on very variable characters.

PECTINIA Oken.

Pectinia mæandrites M.-Edw. & H.

Very rare. When examined with a magnifier, the septa are seen to be distinctly though very finely serrate.

DENDROGYRA Ehrbg.

Dendrogyra cylindrus Ehrbg.

Very rare; only found occasionally thrown up on the beaches. Fine specimens in the Museum received from Mr. Duchassaing, of Guadaloupe, show very distinctly the mode of growth of the prongs arising from large hemispherical masses.

Subfamily ASTRÆINÆ M.-Edw. & H.

ASTROCÆNIA M.-Edw. & H.

This genus is known only from the oolitic, cretaceous, and tertiary formations. It was placed by Milne-Edwards and Haime among the Stylinaceæ, on account of its supposed entire septa. Reuss, who had better preserved specimens, has shown that they are denticulated. I have found this character strongly marked in some specimens of *A. reticulata* from Gosau, particularly in some calicles placed in a cavity where they had been protected from abrasion.

Heller has referred to this genus a small coral discovered by him in the Adriatic. From the description and figure, however, it would seem to be a Madracis, as it has ten equal septa.

Astrocænia pectinata Pourt.

Corallum small: incrusting. Calicles crowded: wall forming a sharp ridge; costæ spinous, generally not confluent. Fossa deep. Septa in two cycles, not very different from each other; six complete systems; the lamella of the septa rudimentary, but extending into long spines, which join the columella in the lower parts. Columella rather stout, conical, hollow, free to a considerable depth. Dissepiments not numerous. Growth by lateral gemmation. Diameter of calicles 1.5 mm.

On base of a *Madrepora prolifera*, in Mus. Comp. Zoöl.

LITHOPHYLLIA M.-Edw. & H.

Under this name the young of several other genera have probably been described, such as Mussa, Isophyllia, Symphyllia, etc. The question can only be decided by series of specimens in different states of development. I leave the following species under that genus for want of that test, but should hesitate much before giving them a definite place in the system.

Lithophyllia cubensis M.-Edw. & H.

L. argenome? Duch. & Mich.
L. cylindrica? Duch. & Mich.

Two specimens obtained at Tortugas show no appearance of division into lobes, though 3 to 3.5 cm. in diameter; another smaller specimen comes from Bermuda. The septa and their spines are covered laterally with small spiniform tubercles, which give them a hirsute appearance. The spines of the younger septa are irregular, branching, sometimes coalescing and perforated. My specimens were found growing on dead branches of *Madrepora cervicornis*.

Lithophyllia dubia Duch. & Mich.

A fine specimen of this supposed species agrees with the figures of Duchassaing and Michelotti. I suspect it to be the young form of an Isophyllia or Mussa (perhaps *Mussa carduus*). My specimen shows a beginning of division into lobes. It was obtained on the reef at Looe Key.

ISOPHYLLIA M.-Edw. & H.

Isophyllia multilamella Pourt.

Lithophyllia multilamella Duch. & Mich. (young specimen).

The differences between Isophyllia and Symphyllia are so slight as to lead to continual confusion. I prefer to merge them under the above name.

The septa in this species are very closely set, there being from 13 to

15 in a centimeter. The ridges are sometimes slightly flattened on top and marked generally with a narrow but distinct furrow. Columella well developed, papillose.

Though not sure of the identification, as indeed will be mostly the case in any attempt to identify the numerous species of Symphyllia too imperfectly characterized by Duchassaing and Michelotti. I prefer not to introduce a new name, as there are, no doubt, many superfluous ones in the number.

The Museum of Comparative Zoölogy has a specimen from Florida and one from Bermuda.

Isophyllia dipsacea Ag. Ms.

Symphyllia? dipsacea Edw & H.
Mussa dipsacea Dana.
Non *Symphyllia guadulpensis* Edw. & H.

Rather common, quite a number of fine specimens in the Museum of Comparative Zoölogy.

Isophyllia guadulpensis Pourt.

Symphyllia guadulpensis M.-Edw. & H.
Isophyllia rigida Verrill.
Non *Astræa rigida* Dana.

The specimens labelled by Mr. Verrill all agree in having lamellar costæ when young, much more marked than in any other species. The other characters are rather vague.

The diagram of the calicles of *Astræa rigida* given by Dana showing a hexagonal limitation of the calicles, so different from the irregular, partly meandriform shape of those of the species in question, seems to preclude the identification as made by Verrill. The imperfect description seems to call for a new one. Corallum flat-hemispherical; epitheca rudimentary or none; costæ sublammellar, particularly in the young, spinulous; calicles rarely simple, mostly in sinuous series with two or three centres. Ridges rounded, with very small furrow on top. Septa closely set, rather equal, 10 to 12 to a centimeter, sparsely granular on their faces, with rather strong triangular teeth; columella papillose.

The young divide quite regularly into six lobes, corresponding to the systems, the primary septa enlarging and forming the partitions between the lobes.

MYCETOPHYLLIA M.-Edw. & H.

Mycetophyllia Lamarckana Edw. & H.

Rather rare. I have found it living on the reef at Looe Key, and dredged it up from five fathoms in the channel at Key West.

Mycetophyllia Danaana Edw. & H.

Several worn specimens in the Museum are referred to this species; also a young one obtained living by myself.

MUSSA Oken.

Mussa angulosa Oken.

Rare.

Mussa carduus Dana.

Rare. Worn specimens.

MANICINA Ehrbg.

Manicina areolata Ehrbg.

Very common from about three feet below low-water mark to five or six fathoms, chiefly in sheltered places. It is particularly abundant on sandy or muddy flats, partly overgrown with sea-grasses (Thalassia), inside the reef. The young when developing normally assume a very elongated form with wavy sides, which soon form six lobes, two of them forming the ends; but the primary or secondary septa are not enlarged, as in Isophyllia, to form the partitions between the lobes.

Although a great diversity prevails in the adults, with regard to the general shape, I can find no specific differences among the large number of specimens examined. I have not seen authentic specimens of the other species enumerated by the authors as found in the West Indies; but from the descriptions I can see no good reason for admitting more than one West Indian species.

MÆANDRINA Lamk.

Pallas had already pointed out the difference between the meandriform corals with entire septa (Pectinia) and those with denticulate septa (Mæandrina); the former he called *Madrepora labyrinthica*, the latter *Madrepora mæandrites*. After him, however, they were placed in the same genus by most of the authors, until Oken finally separated them. Milne-Edwards and Haime subdivided the true Mæandrinæ into several genera, though not always very successfully. Thus Manicina and Mæandrina are said to differ by the presence of paliform lobes in the former and their absence in the latter, whilst in reality they are fully as much developed in most of the Mæandrinæ as in Manicina. These genera differ only by their mode of growth.

The genus Cœloria, of the same authors, has been separated from Mæandrina by exceedingly vague characters; it is not difficult to find parts of the same polypidom which could be made to fit one or the other of these genera. No doubt much of the confusion existing in this group is due to a considerable range of variation in the same species, and to the large proportion of worn specimens which have served as types for description.

I can recognize with tolerable certainty but three species on the coast of Florida.

Mæandrina labyrinthiformis Oken (Mæandra).

Madrepora labyrinthiformis (pars) Linn.
Madrepora labyrinthica Ellis & Sol. Pl. 46, figs 3 and 4.
Madrepora mæandrites (pars) Esper. Pl. 4 A.
Mæandrina labyrinthica Dana.
Cœloria labyrinthica M.-Edw. & H. Ann. Sci. Nat., 3e Sér., t. XI. p. 294, 1849.
Cœloria labyrinthiformis. M.-Edw. & H. Hist. Nat. des Coralliaires, 1857.

The figures of Ellis and Esper render the identification of this species tolerably certain, although it is probable that two species, one of them from the Red Sea, have been confounded under that name. After the two shall have been compared and probably separated, the question will arise as to which of the two is to retain the old name.

Duchassaing and Michelotti have not enumerated it among their West Indian corals.

It is less common in Florida than the two other species, and is found very little below low-water mark. One specimen, presented to the Museum by Captain W. A. Jones, U. S. E., was taken from a block of concrete at Fort Jefferson, Tortugas, which had been in the water twenty years. It measures a foot in diameter and about four inches in thickness in the most convex part.

Mæandrina clivosa Ellis & Sol.

Mæandrina grandilobata Edw. & H.
Mæandrina mammosa Dana.

The most common form is well characterized by its rather flat growth, with very gibbous and tuberculated surface, very distinct calicular centres, marked by an enlargement of the columella and convergence of the lower part of the septa; paliform lobes small, thickened, but not generally connected laterally; columella very rudimentary between the calicular centres; secondary septa very regular, about half as thick and long as the primaries.

This species is exceedingly common in Florida, but does not in general form very large masses.

Mæandrina strigosa Dana.

Cæloria strigosa M.-Edw. & H.

Dana's description agrees in every point with our most common and largest Florida species. It is not mentioned in the synonymes of the species enumerated by Milne-Edwards and Haime, among which none can be found which agrees in its characters with our specimens.

There are two varieties apparently. The most common one has rather narrow gyri, thin walls, paliform lobes distinct but not very prominent. The second form has wider gyri, wall rather thick and sometimes flattened and slightly furrowed on top, making an approach to Diploria; paliform lobes very distinct. In both forms the secondary septa are seldom present. A specimen in the Museum shows the transition from one form to the other.

The second form has been enumerated by Professor Verrill in the Bull. Mus. Comp. Zoöl., No. 3, as *Mæandrina sinuosa* Lesueur, but Lesueur's description is quite insufficient to identify the species he had in view.

COLPOPHYLLIA M.-Edw. & H.

Colpophyllia gyrosa M.-Edw. & H.

Rather common, but seldom seen alive in less than one fathom. It is found dead abundantly on top of the reef at low-water mark.

DIPLORIA M.-Edw. & H.

Diploria cerebriformis M.-Edw. & H.

Not common.

FAVIACEÆ M.-Edw. & H.

FAVIA M.-Edw. & H.

Favia Oken (pars).
Fissicella Dana (pars).
Parastrea M.-Edw. & H. Ann. Sc. Nat., 3e Sér., t. XII., 1850.
Favia M.-Edw. & H. Hist. Nat. des Corall., 1857.

Favia ananas Oken.

Madrepora ananas Pallas.
Madrepora ananas Ellis & Sol. Plate 47, fig. 6.
Favia ananas Oken.
Parastrea ananas M.-Edw. & H. l. c. 1850.
Favia ananas M.-Edw. & H. l. c. 1857.

Very common, very nearly up to low-water mark.

There are many specimens of this species in the Museum, particularly young and worn ones, which would undoubtedly be referred to the genus Goniastræa if seen by themselves. In a series, however, the passage from one form to the other is readily seen, and can even be followed out sometimes in the same specimen. Thus the line of separation between the two genera is very difficult to be drawn.

Favia rotulosa M.-Edw. & H.

Madrepora rotulosa Ell. & Sol. Pl. 55.
Astrea rotulosa Lamk.

Rare; the Museum possesses only one worn specimen.

ASTRÆACEÆ M.-Edw. & H.

ORBICELLA Dana.

Heliastræa M.-Edw. & H. Hist. Nat. des Corall.
Astræa M.-Edw. & H. Compt. rend. de l'Acad. des Sc. 1848, and Ann. des Sc. Nat., 3e Sér., t. XI.

The name adopted by Dana covers so nearly the same ground as the generic division called Heliastræa by Milne-Edwards and Haime, that it is retained here, as had already been done by Mr. Verrill in the Bull. Mus. Comp. Zoöl., No. 3.

Orbicella cavernosa Verrill.

Madrepora radiata? Ellis. (*Astræa, Heliastræa, Orbicella radiata* Auct.)
Madrepora cavernosa Esper, Pflanz. Suppl., p 18, Pl. 37.*
Astrea argus Lamk.
Tubastræa cavernosa Blainv.
Orbicella argus Dana.
Astrea cavernosa M.-Edw. & H. Ann. des Sc. Nat., 3e Sér., t. XI.
Heliastræa cavernosa M.-Edw. & H. Hist. Nat. des Corall.
Heliastræa conferta? M.-Edw. & H.

There is considerable variation among the specimens from Florida in the Mus. Comp. Zoöl., enough apparently to warrant placing them among the three species named in the synonymy; but by carefully examining the different parts of each specimen, passages from one to the other can be found. Thus young polypidoms, expanding rapidly laterally, and with rather distant polyps, appear at first to differ considerably from strongly convex ones with crowded calicles; the costæ are longer, flatter, and less sharply denticulate, and the border of the calicles less elevated.

The size of the calicles, relied on to divide the genus into groups, by Milne-Edwards and Haime, is a very uncertain character; one specimen has in one part the calicles varying from 3.5 to 4.5 mm., in another part from 7 to 8 mm. The same specimen has in some parts the contiguous walls united solidly, with very few or no exothecal cells, in others separated by an abundant cellular exotheca. In worn specimens the last cycle disappears first, for that reason probably *Orbicella* (*Madrepora*) *radiata* Ellis has been characterized by Milne-Edwards and Haime as having but three cycles.

This coral is generally found from 2 to 15 fathoms deep, forming sometimes masses of considerable size. It is also occasionally found in smaller masses in lesser depths on the reef.

* I have not seen this figure, the copy of Esper which I have consulted being incomplete.

Orbicella annularis Dana.

Madrepora annularis and *faveolata* Ellis & Sol.
Astrea annularis Lamk., Lamx., M.-Edw. & H.
Tubastrea annularis Blainv.
Explanaria annularis Ehr.
Heliastræa annularis M.-Edw. & H.
Heliastræa stellulata? M.-Edw. & H. (and synon.).

The same remarks about variation, given under the head of *O. cavernosa*, can be applied to this species; there are very fine examples in the Museum of the great variation of form of the calicles in the same specimen.

It is very common in Florida on the reef and in the channels, and forms large hemispherical masses nearly up to low-water mark. The central and highest part often dies out from being left uncovered at very low tide, and the mass then assumes an annular form through the decay of the dead part. I cannot find, however, if the specific name was derived from this fact.

SOLENASTRÆA M.-Edw. & H.

Astrea (pars) Michelin. Icon. Zoöph.

Solenastræa excelsa Pourt.

Orbicella excelsa Dana, Zoöph. Page 212, Pl. 10, fig. 16.
Solenastræa Bournoni M.-Edw. & H.
Madrepora pleiades? Ell. & Sol. Pl. 53, figs. 7 and 8.
Madrepora stellulata? Ell. & Sol. Pl. 53, figs. 3 and 4.
Non *Orbicella pleiades* Dana.
Solenastræa Ellisii Duch. & Mich.
Orbicella hyades? Dana.
Orbicella stellulata? Dana.

The earliest name ought to be Ellis's; but as there is a doubt, on account of the imperfect description and figure, it is better to adopt Dana's, the original of whose description I have compared in the Museum of the Boston Society of Natural History; although somewhat worn, it can be identified without doubt.

Orbicella hyades Dana I suspect to be identical with this, but I was unable to find the original specimen said to be in the same collection.

To Milne-Edwards and Haime's description ought to be added that the columella is solid, with slightly concave papillose surface, but may be quite absent in young calicles; there is a considerable range of variation in the same corallum. It is not common in Florida.

Solenastræa micrus Duch. & Mich., with vesicular columella, probably belongs to some other genus.

CLADOCORACEÆ M.-Edw. & H.

CLADOCORA M.-Edw. & H.

Caryophyllia (pars) Lamk.
Cladocora (pars) Ehrbg.
Caryophyllia (pars) Dana.

Cladocora brevis Pourt.

Corallum forming a dense cluster, the corallites rising in part from an expanded base, but chiefly budding from the wall at a very open angle. No epitheca, or only a false one, at the base of the clusters. The corallites very short (5 to 6 mm.), with finely granulated costæ distinct to the base. Fossa rather deep. Septa rounded above, slightly exsert, minutely serrate; the fourth cycle developed in one half of each system generally. Pali well developed and at different distances from the centre. Columella a rather dense mass of papillæ with concave surface. Diameter of calicle 3.5 to 4 mm.

Florida Reef, rare.

This species resembles *C. parvistella* Duch. & Mich., but differs from it by its fuller development of the fourth cycle, larger size of calicles, more complete pali, etc. The general appearance is very much like *Cladocora multicaulis* M.-Edw. & H. (*Lithodendron multicaule* Michelin), but it has smaller calicles.

Cladocora arbuscula M.-Edw. & H.

Caryophyllia arbuscula Lesueur.

Very abundant; it is found in quantities on muddy shoals, in company with *Porites furcata*, and extends downwards to about 13 fathoms. (See Deep-Sea Corals, p. 30.)

ASTRANGIACEÆ M.-Edw. & H.

Astranginæ Verrill.

PHYLLANGIA M.-Edw. & H.

Phyllangia americana M.-Edw. & H.

Syndepas Gouldii Lyman.
Stellangia reptans? Duch. & Mich.

The typical and only species of the genus Syndepas Lyman appears to me identical with Phyllangia americana M.-Edw. & H., with which Mr. Lyman was probably not acquainted at the time he wrote. The Museum of Comparative Zoölogy has numerous specimens from the Florida Reef and from Cumana, Venezuela; it appears to be quite common in both localities.

The paliform lobe noticed in the genus by Professor Verrill is sometimes well developed in this species, at other times quite absent.

ASTRANGIA M.-Edw. & H.

Astrangia solitaria Verrill.

Astrangia soli'aria Verrill. Bull. Mus. Comp. Zoöl., No. 3.
Caryophyllia solitaria Lesueur. Jour. Phil. Ac. Nat Sc. I., p. 180, Pl. 8, fig. 11, 1817; and Mém. du Mus. d'Hist. Nat., t. VI. p. 273, Pl. 15, fig. 1.
Astrangia phyllangioides? Duch. & Mich.

This species has never been fully described; it has been identified by Verrill with Lesueur's species, but the characters given by the latter author are so scanty that there can be no certitude of the identity, but a strong probability.

Corallites cylindrical, in loose incrusting clusters, connected by thin stolons on which the costal striæ are distinctly continued. Costæ flat and broad, finely granulated. The base is generally covered with nullipores simulating an epitheca, and covering at length the stolons. Calicle circular, very deep when full grown, shallow in the young. Septa thick, crowded, in four cycles; the fourth generally wanting in two or three half-systems. The primaries are considerably thicker than the others, and more exsert; all the septa are coarsely and bluntly denticulated. Pali well developed, thick, and denticulated. Those of the third united to those of the second order. Columella papillose,

well developed, concave. Diameter of calicles 5 to 6 mm. Height of corallites 8 mm. or less.

Quite common on old corals on the Florida Reef.

Astrangia palifera Verrill, from the East Indies, is very closely allied to this species. They form a little group of passage from the Astrangiæ to the Phyllangiæ, and have also affinities with the Cyliciæ and Rhizangiæ.

A. astræiformis M.-Edw. & H. does not properly belong to the reef fauna, but is found to the east and west of the Florida Reef. *Astrangia Danæ* Ag. is found between Cape Cod and Cape Hatteras. The differences between these two species are of the slightest character, being chiefly derived from the mode of grouping, which is denser in the first than in the second. I am strongly inclined to believe that they will ultimately be united.

COLANGIA Pourt.

Colangia immersa Pourt.

(See Deep-Sea Corals, page 31.)

Family FUNGIDÆ Dana.

Subfamily LOPHOSERINÆ M.-Edw. & H.

The subfamily of Funginæ has no representatives in the shoal-water fauna of the Atlantic basin, but is represented, though quite scantily, in the deep-sea region, as we have seen. The limits of the subfamily of Lophoserinæ require revision; at least it does not appear natural to place in different families genera so closely allied as Fungia and Diaseris or Cycloseris.

SIDERASTRÆA M.-Edw. & H.

Astræa (pars) Lamk., Oken.
Siderastrea (pars) Blainv.
Siderina Dana.
Siderastrea M.-Edw. & H. Compt. rend. de l'Acad. des Sc., t. XXVII., 1848; and Ann. Sc. Nat. 3e Sér., t. XII., 1850.
Astræa M.-Edw. & H. Hist. Nat. des Corall., 1857.

For the reasons why the name Siderastræa should be retained in preference to Astræa, see Verrill, Bull. Mus. Comp. Zoöl., No. 3.

Siderastræa galaxea M.-Edw. & H.

Madrepora galaxea Ell. & Sol.
Madrepora astroïtes Esper. Pl. 35.
Siderina galaxea Dana (includes two species, probably).
Siderastrea galaxea M.-Edw. & H. Ann. Sc. Nat., 3e Sér., t. XII., 1850.
Astræa radians M.-Edw. & H. Hist. Nat. des Corall., 1857.

Of the two species, *S. galaxea* and *siderea*, it is doubtful which one Pallas had in view when describing his *Madrepora radians*. Ellis and Solander have left no doubt about the species, both by the figure and description, which distinctly point to three cycles of septa only; their specific name ought therefore to be retained. (There are probably still two species confounded under the same name, one of them being from the East Indies.)

This species forms generally smaller masses than the next, frequently ball-shaped and free. In altitude it ranges higher than any other coral of the Floridian fauna, as small masses are found flourishing in pools left by the tide; I have even seen small clusters left partially dry in a hot sun, keeping up a communication with the water only by the few lowest polyps of the group. From their position they must have frequently been thus exposed, without inconvenience. According to Professor Agassiz, the polyp has bilobed short tentacles, at different distances from the centre.

Siderastræa siderea Blainv.

Madrepora siderea? Ellis & Sol. Pl. 49, fig. 2.
Astrea siderea Lamk.
Pavonia siderea Dana.
Siderastræa siderea M.-Edw. & H. Ann. Sci. Nat., 1849.
Astræa siderea M.-Edw. & H. Hist. Nat. Coral., 1857.

All the authors previous to Milne-Edwards and Haime appear to have simply repeated Ellis and Solander's description, which is very vague; the figure accompanying it has very little resemblance to the coral to which we are in the habit of applying the name, so that I think it is very probable that some other coral was meant.

It is very common on or about the reef, and forms sometimes considerable masses.

MYCEDIUM Oken.

Mycedium fragile Dana.

(See Deep-Sea Corals, page 48.) I do not know the upper limit in depth of this species, having never seen it in shoal water. It is represented in the Museum by numerous fine specimens collected by different persons who did not use a dredge, so that it must probably reach to two or three fathoms from the surface.

Agaricia undata is mentioned by Dana as being found at Key West. There is no specimen in the Museum. It is found near Havana. (*Coll. Arango.*)

AGARICIA Lamk.

Agaricia agaricites M.-Edw. & H.

Madrepora agaricites Pallas.
Madrepora agaricites Ellis & Sol. Pl. 63 (indifferent figure).
Pavonia agaricites Lamk.
Mycedia agaricites Dana.

Quite common on the reef, forming occasionally large clusters on the sides of masses of other corals.

Agaricia purpurea Lesueur.

Mycedia purpurea Dana.

On the authority of Professor Verrill, I include this species among the Florida corals. The Museum of Comparative Zoölogy has no undoubted specimens of it from that coast, but has some from Hayti, of large size. Young specimens would probably be difficult to distinguish from young *A. agaricites*, which is at first unifacial.

Family STYLASTERIDÆ Gray.

STYLASTER Gray.

Stylaster sanguineus? Val.

Three specimens of a Stylaster from Florida in the Museum of Comparative Zoölogy, labelled and catalogued as *Stylaster roseus*, cannot be distinguished from a specimen from New Zealand, which agrees with the description and figure of *St. sanguineus* Val., in the Monograph of the Oculinidæ by Milne-Edwards and Haime, in *Annales des Sciences Naturelles*.

Another specimen from Florida is kept in the Museum of Yale College in New Haven, as I am informed by Professor Verrill. The depth from which it was obtained is not stated, but it must be from comparatively shallow water, as it was obtained by parties not provided with dredges. I have never found it myself. I have marked it doubtful as to its specific identification, on account of the very distant habitat of the specimens originally described. This is the species mentioned as *St. roseus* Gray, in Bull. Mus. Comp. Zoöl., No. 3. The latter is abundant on the under surface of blocks of coral rock, on the reef at Cruz del Padre, north coast of Cuba, a couple of feet below low-water mark. It is not found on the Florida Reefs.

Family MADREPORIDÆ Dana.

For reasons stated elsewhere, the Eupsammidæ ought to be excluded from this family, the limits of which would be thus nearly those established by Dana; the proper position of the Montiporæ (Manoporæ Dana) still requires investigation.

MADREPORA Linn. (*pars*).

Madrepora palmata Lamk.

Madrepora flabellum Lamk.
Madrepora alces Dana.
Madrepora cornuta Duch. & Mich.
Madrepora Thomasiana? Duch. & Mich.

The conclusion arrived at from the comparison of a large number of specimens, of all ages and sizes, is the specific identity of *Madrepora*

palmata, alces, flabellum, and *cornuta.* These forms pass from one to the other by gradations, among which it is impossible to draw the limit. The flabellum form prevails in rapidly growing specimens, as then the edge is thin and the component small branches more distinct; but that mode of growth is seen also in the more slowly growing ones, where the branchlets are only more crowded and shorter, and hence more difficult to distinguish. The characters derived from the calicles are affected by the same causes.

What the *Madrepora Thomasiana* of Duchassaing and Michelotti may be is not very apparent from their description; it is probably a variety of the *palmata* also.

This coral is the principal reef-builder, and is seldom found elsewhere than on the outside reef, where it is well exposed to the surf. It grows up to low-water mark, but its lower limit I have not ascertained.

Madrepora cervicornis Lamk.

This species is found on the reef in rather small isolated bunches; at Tortugas it is, however, very abundant, forming dense forests in a sort of lagoon in front of Fort Jefferson; it extends from the bottom to low-water mark in one or two fathoms of water, and requires a rather sheltered position for its full development. I have seen living branches brought up on fish-hooks from seven fathoms.

Madrepora prolifera Lamk.

Somewhat less common than the preceding. Some specimens partake so much of the characters of both this and the preceding species as to shake the belief in their specific difference. Still, the greater number of specimens examined are readily distinguished, more perhaps by their habitus than by the more minute characters of the calicles.

Family PORITIDÆ Dana.

PORITES M.-Edw. & H.

Porites Lamk. (pars).

Porites clavaria Lamk.

Very abundant, principally about the reef.

Porites furcata LAMK.

Very abundant, in shoal water down to 2 or 3 fathoms.

Porites astræoides LAMK.

Very abundant.

Of the numerous species of Porites enumerated by the authors, and particularly by Duchassaing and Michelotti, as belonging to the West Indian fauna, I can identify but the three above species as found in Florida. *Porites clavaria* and *furcata* are even rather difficult to distinguish by any constant characters derived from the calicle, as they vary considerably in the same specimen.

The numerous species described by Duchassaing and Michelotti I have had no opportunity to study. Their genus Neoporites, for the massive species of which *P. astræoides* is a type, is a good subgenus. The calicle presents sufficient differences, although the pali are not really absent, but are represented by a tooth of the septum concealed by the vertical edge of the latter.

ORDER ACALEPHÆ.

SUBORDER HYDROIDÆ JOHNST.

Family MILLEPORIDÆ Agassiz.

MILLEPORA LINN.

Millepora plicata ESPER.

Millepora alcicornis LINN., PALLAS.
Millepora alcicornis, var. γ, *plicata* ESPER., Tab. VIII.
Millepora complanata? LAMK., DANA, M.-EDW. & H., DUCH. & MICH.
Millepora foliata? M.-EDW. & H., DUCH. & MICH.
Millepora faveolata? DUCH. & MICH.
Millepora striata DUCH. & MICH.
Millepora tuberculata? DUCH. & MICH.

This species is less common than *M. alcicornis*. I have found it well developed on the reef only, whilst the other is found everywhere. Characters derived from the calicles or pores are apt to deceive; still in general, in this species, the larger calicles occupy the centre of a

slight depression, and are surrounded by five or six small ones. This arrangement is subject to many exceptions, however. The smaller calicles are about half the diameter of the larger ones. This species incrusts foreign objects, like the other ones. It is represented on a Gorgonia by Seba, Tab. 106, No. 8. A similar specimen is in the Museum, collected by myself in Florida.

Millepora alcicornis Lamk.

Millepora alcicornis (pars) Linn.
Millepora alcicornis Pallas (var. *a*, 1 and 2).
Millepora alcicornis Esper. (var. *a*, and 2).
Millepora alcicornis Dana.
Millepora alcicornis Duch. & Mich.
Millepora crista-galli Duch. & Mich.
Millepora delicatula Duch. & Mich.
Millepora Schrammi Duch. & Mich.

This species is very polymorphous, but in general can be recognized by its small and numerous digitations, showing a flabellate tendency, sometimes flattened into a coxcomb shape at the end of the branches; very small calicles, without depressions generally, or if so, both large and small in saucer-like pits. Duchassaing and Michelotti have apparently multiplied the species unnecessarily; one West India form is, however, probably different, being very slender from the stem to the branches, spreading, and seldom coalescing; it is probably the variety *ramosa* Pallas; *Millepora ramosa* Dana. I have not observed it in Florida.

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[Synonymes are in Italics.]

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DESCRIPTION OF THE PLATES.

PLATE I.

Fig. 1. Stenocyathus vermiformis Pourt., profile of calicle, mag. 7 times (see also Plate III. figs. 11 and 12).
" 2. The same from above.
" 3. Lophohelia prolifera M.-Edw. & H., nat. size.
" 4. The same, calicle in profile, showing bud, mag. 3 times.
" 5. The same from above.
" 6. Lophohelia exigua Pourt., nat. size.
" 7. The same, calicle from above, mag. 5 times.
" 8. Dendrophyllia cyathoides Pourt., nat. size.
" 9. The same, calicle from above, mag. about 3 times.
" 10. Thecopsammia tintinnabulum Pourt., nat. size.
" 11. The same, calicle from above.
" 12. Cœlosmilia fecunda Pourt., nat. size.
" 13. Parasmilia variegata Pourt., nat. size.
" 14. Caryophyllia cornuformis Pourt., mag. 4 times.
" 15. The same, calicle from above.
" 16. Caryophyllia formosa Pourt., nat. size.
" 17. Desmophyllum Cailleti Duch. & Mich., nat. size.
" 18. The same, calicle from above, mag. twice.

PLATE II.

Fig. 1. Deltocyathus Agassizii Pourt., from above, mag. twice.
" 2. The same, in profile.
" 3. The same, from below.
" 4. The same, variety, from below (see also Plate V., figs. 9 and 10).
" 5. The same specimen, from above.
" 6. Diaseris pusilla Pourt., from above, mag. twice.
" 7. The same, septa in profile, mag. 4 times.
" 8. The same, specimen of fig. 6, from below.
" 9. Thecopsammia socialis Pourt., mag. 1½ times.
" 10. The same, calicle from above.
" 11. Haplophyllia paradoxa Pourt., nat. size.
" 12. The same, calicle from above.
" 13. The same, vertical section.
" 14. Thecocyathus cylindraceus Pourt., mag. 3 times.
" 15. The same, from above.
" 16. Stylaster complanatus Pourt., nat. size.
" 17. The same, calicle from above, mag. 50 times.
" 18. Cryptohelia Peircii Pourt., nat. size.
" 19. The same, two calicles, mag. 4 times.

PLATE III.

Fig. 1. Leptocyathus Simpsonii Pourt., mag. 4 times.
" 2. The same, from above.
" 3. The same, from below.
" 4. Cœlosmilia fecunda Pourt, mag. twice.
" 5. The same, calicle, mag. 4 times. (The specimen has a small rudiment of a columella, but by no means as large and distinct as represented by the artist.)
" 6. Galaxea eburnea Pourt., mag. twice.
" 7. The same, calicle from above.
" 8. Ceratocyathus prolifer Pourt., specimen showing mode of budding from calicle of parent, nat. size.
" 9. The same, calicle from above, mag. 3 times.
" 10. The same, vertical section, showing dissepiments.
" 11. Stenocyathus vermiformis Pourt., specimen with calicles at both ends, nat. size.
" 12. The same, calicle magnified (more common form than Plate I., fig. 2).
" 13. The same, part of horizontal section, showing small cavities communicating with interseptal chambers.
" 14. Allopora miniacea Pourt., nat. size.
" 15. The same, branchlet, mag. about twice.
" 16. The same, calicle, mag. 10 times.
" 17. Lepidopora cochleata Pourt., nat. size.
" 18. The same, end of branchlet, mag. about 50 times.
" 19. The same, vertical section, mag. about 50 times.

PLATE IV.

Fig. 1. Rhizotrochus fragilis Pourt., mag. twice.
" 2. The same, calicle from above.
" 3. The same, horizontal section, to show internal orifices of the roots.
" 4. The same, horizontal section through the peduncle, to show the hollow roots.
" 5. Balanophyllia floridana Pourt., mag. twice.
" 6. The same, calicle from above.
" 7. Pliobothrus symmetricus Pourt., nat. size
" 8. The same, end of branch, mag. 4 times.
" 9. Pliobothrus tubulatus Pourt., nat. size.
" 10. Stylaster erubescens Pourt., small specimen, nat. size.
" 11. The same, branchlet, mag. 4 times.
" 12. Distichopora foliacea Pourt., nat. size.
" 13. The same, side view of branchlet, mag. 4 times.
" 14. Distichopora sulcata Pourt., side view of branchlet, mag. 4 times (see Plate VII., fig. 7).

PLATE V.

Fig. 1. Diaseris crispa Pourt., mag. 5 times.
" 2. The same, from above, mag. 4 times.
" 3. Thecocyathus lævigatus Pourt., vertical section showing internal roots setting off from interseptal chambers, mag. 4 times.
" 4. The same, horizontal section through base, showing extremities of internal roots, mag. 4 times.
" 5. Desmophyllum solidum Pourt., mag. twice.
" 6. The same, calicle, from above.
" 7. Dendrophyllia cornucopiæ Pourt., nat. size.
" 8. The same, calicle from above.
" 9. Deltocyathus Agassizii Pourt., variety, from the side (see Plate II., figs. 1 to 5), mag. 3 times.
" 10. The same, from below.
" 11. Oculina tenella Pourt., nat. size.

Fig. 12. The same, calicle, mag. 9 times.
" 13. Stylaster filogranus Pourt., nat. size.
" 14. The same, branchlet mag. 4 times.

PLATE VI.

Fig. 1. Stylaster Duchassaingii Pourt., nat. size.
" 2. The same, branchlet, mag. 4 times.
" 3. Oculina varicosa Lesueur, branchlet, nat. size.
" 4. The same, calicle mag. 4 times.
" 5. Errina carinata Pourt., mag. 6 times.
" 6. Diplohelia profunda Pourt., nat. size.
" 7. The same, calicle mag. 4 times.
" 8. Parasmilia Lymani Pourt., nat. size.
" 9. The same, calicle from above, mag. twice.
" 10. The same, side view of a septum, showing the origin of the false columella and false pali; mag. about 3 times.
" 11. Paracyathus confertus Pourt., nat. size.
" 12. The same, calicle from above, mag. 3 times.
" 13. The same; a single specimen, the more usual form, mag. twice.
" 14. Cœlosmilia fœcunda Pourt., nat. size.
" 15. The same, calicle from above, mag. twice.
" 16. Trochocyathus ? coronatus Pourt., nat. size.

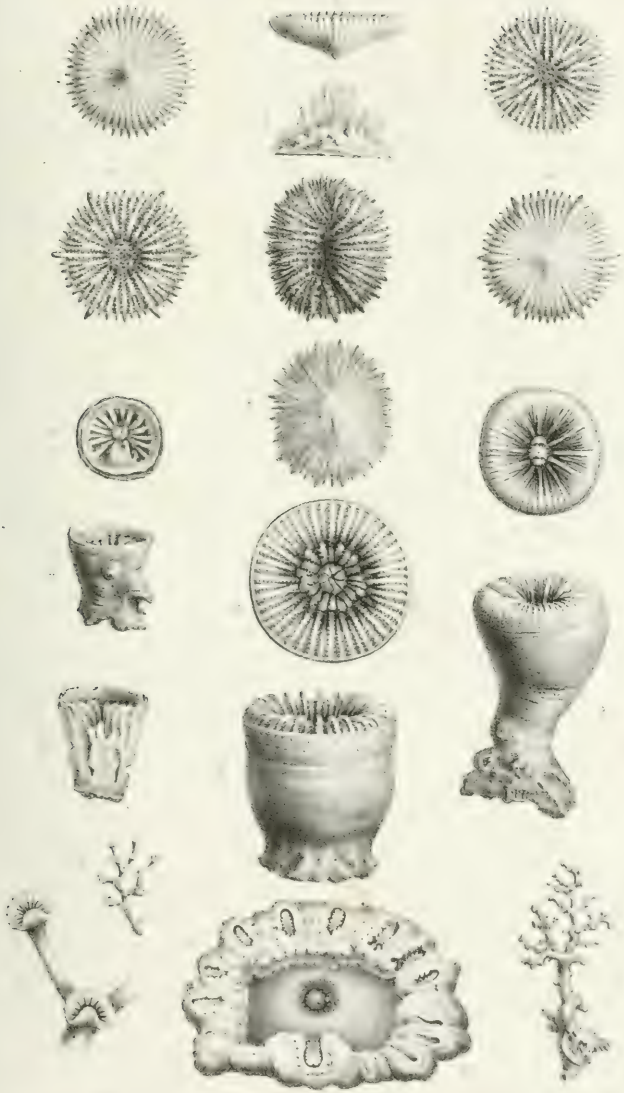
PLATE VII.

Fig. 1. Madracis decactis Verrill, mag. twice.
" 2. The same, calicle, side view, mag. 12 times.
" 3. The same, calicle from above, mag. 12 times.
" 4. Madracis asperula M.-Edw. & H., calicle mag., 12 times.
" 5. Fungia symmetrica Pourt., from above, mag. twice.
" 6. The same, from below.
" 7. Distichopora sulcata Pourt., nat. size (specimen belonging to D. Raphael Arango, in Havana), see Plate IV., fig. 14.
" 8. Lepidopora glabra Pourt., branchlet, mag. 6 times.
" 9. The same, vertical section, to show the columella.
" 10. Lepidopora Dabneyi Pourt., branchlet, mag. 6 times.
" 11. The same, vertical section.

PLATE VIII.

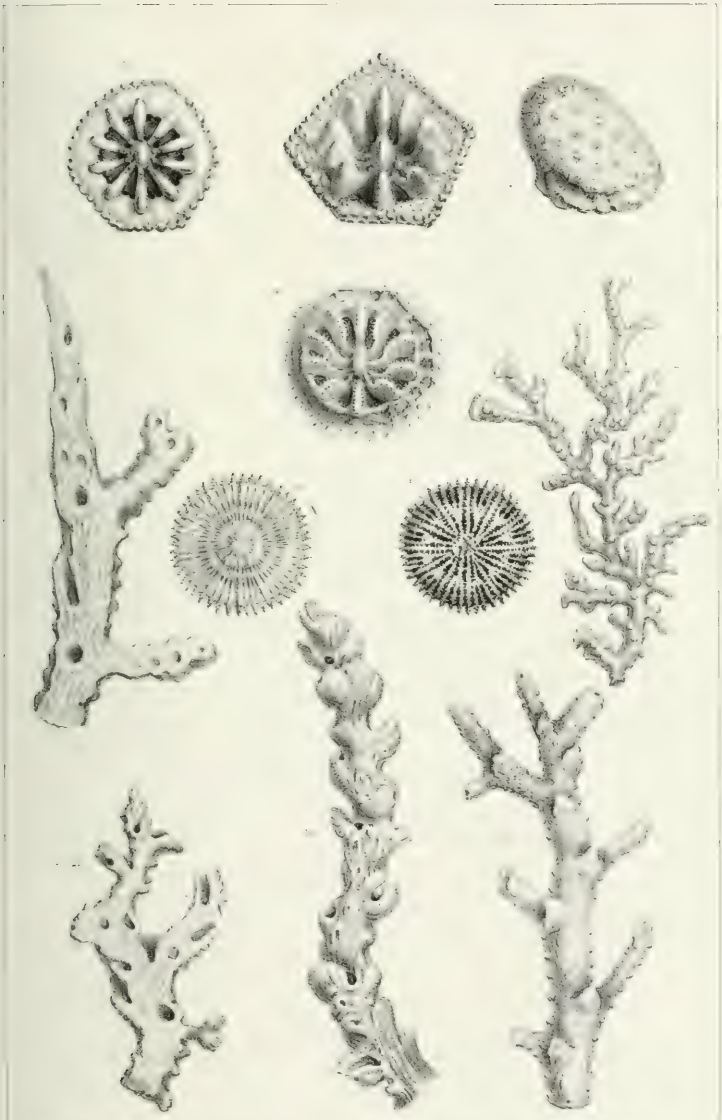
Map of the Straits of Florida.

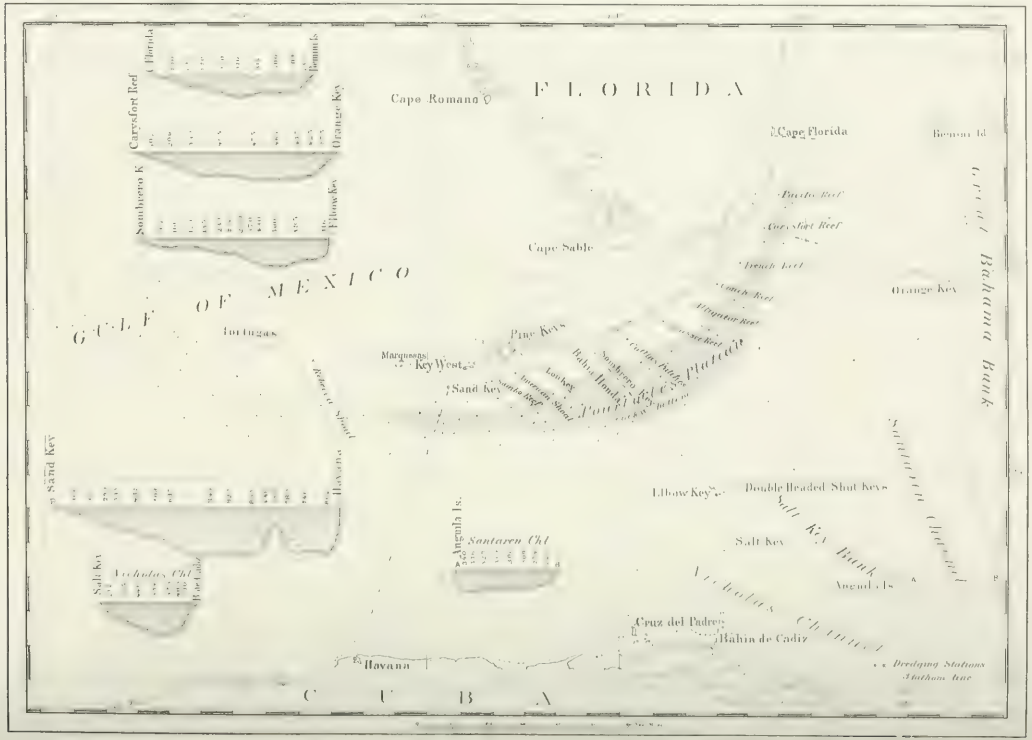
University Press, Cambridge: Printed by Welch, Bigelow, & Co.



P. Roetzel on stone from nat.

Print by H.W. Longfellow





THE SEA BOTTOM BETWEEN FLORIDA AND CUBA.

ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. V.

THE IMMATURE STATE OF THE ODONATA.

PART I. — SUBFAMILY GOMPHINA.

BY

LOUIS CABOT.

CAMBRIDGE:
PRINTED FOR THE MUSEUM OF COMPARATIVE ZOÖLOGY.
1872.

University Press: Welch, Bigelow, & Co.,
Cambridge.

PREFACE.

THE description of the immature state of the species belonging to the subfamily Gomphina is to be followed by that of the other five subfamilies of the interesting family of the Odonata. The materials in the collection of the Museum of Comparative Zoölogy are very rich, as is well shown by the Gomphina. Up to this time two species only have been published, both from Europe; now seventeen are described, viz. eleven from America, of which four are from South America, three from Asia, and three from Europe. The relation of the larvæ described to the actually described imagos is, of course, very small. Baron De Selys Longchamps, in Liège, describes in his monograph of the Gomphina, published with my collaboration, and in the two additions, one hundred and seventy species,—just ten times more than the seventeen immature species here published. But of the six legions of the Gomphina two only are not represented in this monograph,—Chlorogomphus with one species from Japan, and Petalura with three species from New Holland and North America.

Of the species described, only four are raised and identified beyond any doubt, viz. *G. vulgatissimus*, by Dr. F. Brauer; *M. spiniceps*, by Mr. Fr. G. Sanborn; *H. brevistylus*, by the late Dr. T. W. Harris; *C. bidentatus*, by Dr. F. Brauer. All the others are determined by exclusion or supposition, and some of them more or less doubtfully. The general character of the subfamily will be better given with the publication of the nearly related Æschnina.

I am responsible in this monograph for the determination of the species, as Mr. L. Cabot had not studied the imago before, and for the synopsis, taken from his descriptions.

H. A. HAGEN.

July 5, 1871.

BIBLIOGRAPHY.

1742. Reaumur, Mém, T. VI., pl. 37, f. 2 to 8, p. 403, figured and described the nympha of a French Gomphus. The figures are not sufficient to determine the species.

1749. Roesel, Insectenbelustigung, T. II., P. II., pl. 7, f. 1, 2, gives the larvæ and nympha of a Gomphus, perhaps *G. vulgatissimus*. Roesel believes it to belong to *Libellula depressa* or *L. cancellata*, but he states that he had several different species in the same jar, and the figured one is surely a Gomphus. The larva described by Scopoli, Fauna Carniolica, p. 259, as belonging to *Cordulegaster annulatus*, is surely an Æschna, and not a Gomphus.

1839. Burmeister, Handbuch, T. II., p. 831, gives a short notice on the larvæ of the Gomphus.

1853. H. Hagen, Stettin. Ent. Zeit., T. XIV., p. 263, describes *G. vulgatissimus* and *C. bidentatus*, both raised by Dr. F. Brauer.

1857. F. Brauer, Neuroptera Austriaca, p. xv., describes both species raised by him, formerly communicated to Dr. Hagen.

ODONATA.

GOMPHINA.

1. Herpetogomphus species.

Selys, Monogr. des Gomph., p. 69.

Plate I., fig. 2, b, c.

Locality: Brazil. Rio dos Macacos, Thayer Expedition. Nympha, male, full grown. Mus. Comp. Zoöl. Length, 31 mm.; breadth, 7 mm.

Body Æschna-like, rather flat, hairy. Head cordate, flat. Eyes moderately prominent. Ocelli developed; an oblique groove extending from lateral ocellus to front angle of eye: part behind the eyes short, notched at middle, with flat spot on each side; hind angles rounded with circular tubercle. Antennæ, two basal joints short, globular; 3d long, dilated, straight, bent up a little at tip; 4th joint very short, rudimentary. Mask extending to fore legs; breadth half the length, narrower behind, sides bent up; somewhat marginated; middle third of fore-border produced in rounded lobe edged with bristles, and having two small black teeth on each side of middle. Palpi small, not meeting, finely denticulated; end hooks sharp, bent down; movable hooks long, arcuated. Prothorax narrower than head, with short anterior lobe; posterior part rounded, has two quadrangular impressions. Wing-cases reaching middle of fourth segment. Legs short and strong, formed for burrowing. Hind legs more distant at base. Fore and middle legs alike; femora and tibiæ strong, somewhat bent; tibiæ longest: tarsi less than $\frac{1}{2}$ as long as tibiæ, 2-jointed, basal joint very small; claws small, sharp. Hind legs reaching 9th segment, rather flattened; tarsi 3-jointed. Abdomen long, gradually narrowing to tip, somewhat rounded above and flattened below. Segments 2 to 9 have dorsal hooks, thicker on 2d segment, nearly obliterated (accidentally?) on 6th, more marked on those following. Side-border sharp. Lateral spines on segments 7, 8, 9: Segments of equal length, 10th segment a little longer than 9th. Anal appendices long, sharp, pyramidal, 2 inferior ones as long as 10th seg.; superior a little shorter, basal half thickened above; lateral appendices $\frac{1}{2}$ as long as inferior.

As this nympha is very similar to Gomphus, it probably belongs to Herpetogomphus, which is found in South America, while Gomphus is not.

There is in same collection and from same locality a larva 5 mm. long, wing-cases just visible; more hairy; teeth on lobe of mask; inside of palpus more marked; dorsal hooks just visible; middle anal appendix not thickened at base.

2. Gomphus pilipes.

Selys, Monogr. des Gomph., p. 148.

Plate I., fig. 3, a, b, c.

Nympha, full-grown female. Locality: S. Carolina. Coll. Hagen. Museum Comp. Zoöl. Length, 25 mm.; breadth, 10 mm.

Body flat, lanceolate, sparingly covered with hairs. Head cordate, flat. Eyes rather prominent, large. Ocelli developed. Vertex flat, an oblique groove extending from lateral ocellus to front angle of eye. Antennæ, two basal joints globular, 2d a little shortest, 3d twice as long as both basal, straight, 4th rudimentary. Part behind eyes short, notched at middle, hind angles rounded, 2 flat tubercles near hind-border. Mask reaching fore legs, small, oblong, sides bent up; fore border produced at middle third in small rounded lobe, with comb of bristles. Palpi short, not meeting; end hook not longer than denticulations; movable hooks thin, sharp, long. Prothorax narrow, oval, border elevated at sides. Wing-cases reaching to middle of 4th segment. Legs strong, hairy, formed for burrowing. Hind legs more separated at base. Fore and middle legs of equal size, short; femora short, strong, arcuated; tibiæ a little longer, nearly straight; tarsi very short, 2-jointed. Hind legs reaching 8th seg., flat; tarsi 3-jointed; claws short, sharp. Abdomen flat, broad, narrowing after 6th segment. Segments 9 and 10 very contracted. Segments have three spots on each side, 9th a linear spot. No dorsal hooks. Segments 8 and 9 have lateral spines. Side-border sharp. Segments of equal length except two last; 9th longer than 8th; 10th $\frac{1}{2}$ as long as 9th; nearly cylindrical. Anal appendices very short, not $\frac{1}{2}$ as long as 10th segment, pyramidal, sharp, nearly equal in length. Two lateral a little shorter. A small bifid tubercle at end of eighth ventral segment.

Another specimen from South Carolina, Coll. Hagen, is identical, but smaller; 25 mm.

These nymphæ are, of course, only referred to *G. pilipes* as probably belonging there or to a related species.

3. Gomphus vulgatissimus.

Selys, Monogr. des Gomph., p. 129.

Plate I., fig. 1, b, c.

Nympha, male. Length, 31 mm.; breadth, 8 mm. Locality: Europe. Raised by Dr. Brauer, female. Coll. Hagen.

Head cordate, flat. Eyes large, prominent. Ocelli developed. Oblique groove extending from lateral ocellus to front angle of eye. Vertex square, a little elevated. Part behind the eyes short, notched at middle; small elevated spots behind eyes. Antennæ, two basal joints short, globular, 2d shortest, 3d nearly twice as long as both basal, dilated, somewhat bent up at tip, 4th rudimentary. Mask reaching to the fore legs, quadrangular, channelled in middle, sides bent up, cut straight at fore-border, middle third finely denticulated, and surmounted by comb of bristles. Palpi short, arcuated, finely denticulated at basal half, end hook stout; movable hooks long and sharp. Prothorax oval, fore-border elevated, a flat impression on each side. Wing-cases reaching nearly to 4th segment. Legs strong, formed for burrowing. Hind legs more widely separated at base. Fore and middle legs short, about equal size. Femora short, stout, bent inward; tibiæ longer, with strong outer spine at anterior end; tarsi 2-jointed, short, basal joint very short, claws sharp. Hind legs longer, reaching nearly to 9th segment, flat; tarsi 3-jointed, 2d, half the length of 3d. Abdomen long, flat, lanceolate, decreasing in size after 6th segment. Side-border sharp; segments 2 to 9 with large flat spots. No dorsal hooks. Segments 6 to 9 with lateral spines; spines of 9th $\frac{1}{2}$ as long as 10th segment. Segments of equal length, except 10th, which is small, about $\frac{1}{3}$ of foregoing, and cylindrical. Anal appendices a little longer than last segment, pyramidal, sharp. Superior one thickened at basal half; lateral superior ones shorter, sharp.

Have seen both sexes. Female has abdomen a little broader, and at end of 8 ventral segment a small bifid tubercle, superior appendix not thickened at basal half.

4. Gomphus species.

Plate II., fig. 4, b.

Nympha, 31 mm.; breadth, 6 mm.

Locality: Rock Island, Illinois. Coll. Hagen. Mr. Walsh supposed this nympha, judging from perfect insects found in vicinity, to belong either to *G. vastus*, *fluviatilis*, *amnicola*, or *fraternus*.

Very similar to *Gomphus vulgatissimus*, differs in having less prominent tubercles on occiput. Denticulation of palpi deeper. Wing-cases reaching 4th segment. Abdomen considerably narrower, more rounded above; 8th and 9th segments with tubercles on dorsal line, lateral spines on 9th longer than 10th segment, which is very short; 9th segment a little longer than 8th. Anal appendices a little shorter than in *G. vulgatissimus*. Hind legs extending to 8th segment only.

5. Gomphus species.

Plate II., fig. 5.

Nympha full grown, 24 mm. long, 6 mm. broad, similar to *G. vulgatissimus*. Locality: Massachusetts. Coll. Mus. Comp. Zoöl., and Coll. Hagen.

Body tapering less abruptly. Head with flat spots instead of tubercles on occiput. Wing-cases reaching middle of 4th segment. Legs rather more slender. Dorsal hooks on segments 6 to 9; on the other segments rudimentary. Lateral spines on segments 7 to 9; 9th segment longer than 8th, with lateral spines nearly as long as 10th, which segment is rather longer than in *G. vulgatissimus*.

There is another, from same collection, younger, 21 mm. long.

6. Gomphus species.

Plate II., fig. 6, b.

Nympha. Length, 24 mm.; breadth, 7 mm.

Locality: Pole Creek, W. Texas. Coll. Hagen.

Body flat. Head flat, cordate. Eyes rather prominent. Ocelli developed. Part behind eyes rounded. Antennæ, two basal joints globular, 2d smallest, 3d elongated and enlarged, 4th small, rudimentary. Whole head granulated. Mask extending to fore legs, length greater than breadth, moderately channelled in middle, middle third somewhat produced, with comb of bristles. Palpi enlarged and rounded at ends, very finely denticulated. Movable hooks long and sharp. Wing-cases extending to middle of 3d segment. Legs strong. Hind legs more separated at base. Middle and fore legs of nearly equal size, strong, formed for burrowing. Femora and tibiæ arcuated. Tibiæ with strongly marked end spine; tarsi 2-jointed; claws sharp. Hind legs reaching 9th segment; tarsi 3-jointed. Abdomen flat, tapering. Dorsal hooks on all segments except 10th. Lateral spines on segments 7 to 9. Segments of nearly equal length. Lateral spines of 9th much

shorter than the 10th segment. Anal appendices longer than 10th segment, pyramidal, sharp, of nearly equal length. Lateral superior appendices nearly as long as the others.

7. Gomphus species.

Plate II., fig. 2, b, c, d.

Nympha, full grown. Length, 22 mm.; breadth, 7 mm.

Locality: Himalaya, Ghugger Pir, Rev. M. M. Carleton. Coll. Mus. Comp. Zoöl.

Body flat, lanceolate. Head cordate. Eyes large, very prominent. Ocelli indistinct. Vertex flat, two small impressions at fore part. Part behind the eyes short, rounded laterally; hind angles blunt; two flat impressions on each side of median line. Antennæ, two basal joints globular, 2d smallest, 3d long, dilated, bent up, 4th very small, black, cylindrical. Mask extending to fore legs, length greater than breadth, narrower behind, deeply channelled at fore-border, sides bent up; middle 3d of fore-border produced in elliptical lobe, deeply cleft in the middle, with comb of bristles thickened at base. Palpi strong, with sharp, bent hooks; some molar incisions; movable hooks long, bent, sharp. Prothorax oval, narrower than head, rounded, flat. Wing-cases reaching 4th segment. Legs formed for burrowing. Hind legs more widely separated at base. Fore and middle legs stout, about equal in size. Femora and tibiæ arcuated, tibiæ are without the sharp lateral spine at end; tarsi knife-shaped, 2-jointed; claws sharp. Hind legs tarsi 3-jointed, straight. Abdomen flat, dorsum slightly rounded, tapering gradually. Side border sharp. Segments 5 to 9, with lateral spines; no dorsal hooks. Segments of nearly equal length, 10th small, short, cylindrical. Lateral spines of 9th are $\frac{1}{2}$ length of 10th. Anal appendices a little longer than 10th; equal length, pyramidal, sharp. Superior appendix with two tubercles near the tip. Lateral short and sharp.

8. Macrogomphus spiniceps.

Nat. Hist. Soc., Phil., 1862, p. 889.

Plate II., fig. 1, a, b, c.

Nympha. 41 mm. long; 8 mm. broad.

Locality: Taken in transformation by Mr. F. G. Sanborn, July 4, 1867, at Lawrence, Mass.

Body long, narrow. Head cordate. Eyes large, prominent. Ocelli developed. Antennæ, somewhat shorter than head, two basal joints short, globular; 3d twice as long as two preceding, dilated, bent inward at tip, 4th joint rudimentary. Vertex flat; outside of ocelli are visible small tubercles, apparently where the spines of imago are placed. Mask extending to fore legs, somewhat longer than broad, channelled in middle; fore-border a little broadest, cut straight; middle 3d with comb of short hairs. Palpi short, strong, arcuated; tip forming strong bent hook, denticulated just before the end; movable hook as long as palpus, sharp. Prothorax somewhat smaller than head, nearly square, narrowed a little in front, sides and angles rounded; two flat impressions near the front and hind borders. Wing-cases nearly reaching the 4th segment. Legs short, strong, hairy. Hind legs more separated at base; fore and middle legs of equal length, shorter than hind legs; femora very short, bent; tibiæ similar and longer; tarsi nearly $\frac{1}{2}$ as long as tibiæ, 2-jointed; claws bent; the outside claw shorter and stronger than inner one. Hind legs reaching 6th segment, nearly straight, tarsi 3-jointed; basal joint short, two others of about equal length. Legs formed for burrowing. Abdomen somewhat conical, tapering. Segments 1 to 8 nearly equal length, 9th nearly twice as long, narrowed in middle; 10th short and slender; large flat spots on segments 2 to 8; segments 6 to 9 with lateral spines. No dorsal hooks. Anal appendices as long as 10th segment, pyramidal, the two lower broader, not very sharp. All of equal length and like shape.

Male nympha has sexual parts visible on 2 and 3 ventral segments; the opening of sexual parts on middle of 9th; in the female a bifid knob on the articulation between 8 and 9 is visible.

9. Progomphus?? species.

Selys, Monogr. des Gomph., p. 194.

Plate II., fig. 3, a, b, c.

Nympha, full grown male and female. Length, 30 mm.; breadth, 7 mm. Looks rather like Æschna.

Locality: Wareham, Mass. Mus. Comp. Zoöl.

Head stout, rather square, narrowed forward. Eyes not very prominent. Ocelli very well developed. Vertex flat, with irregular hairy spots. Antennæ stout, two basal joints small, globular, 3d long, dilated, very hairy, 4th small, $\frac{1}{4}$ length of 3d, cylindrical, recurved. Behind each eye a circular elevated spot, and between these, two impres-

sions on occiput. Mask extending to fore legs, narrow; length twice the breadth; somewhat enlarged forward, with middle channel widening forward; front border produced in semicircular lobe, edged with hairy comb; the hairs forming this arc enlarged at tip and flattened, inserted in small basal cylinder. Palpi short, bent, ending in blunt hooks, smooth inside; movable hooks long, sharp. Prothorax nearly circular, rounded at fore-border, with two oblique impressions; side-border very slightly raised; prothorax polished, shining, near borders and middle line slightly granulated. Wing-cases extending beyond 4th segment. Legs stout, short, hairy, typical burrowing legs. Hind legs much more widely separated at base than fore and middle legs; middle legs nearer at base than fore legs. Fore legs somewhat stronger than middle legs, the coxæ being highly developed, and the femora triangular, arcuated and dilated at base. Tibiæ thickened at middle, near the end bent and narrowed; tarsi somewhat shorter and bent up; 1st joint very short, 2d long, knife-shaped; hooks stout, rather blunt, outer hook rather shortest. Middle legs similar in shape, coxæ smaller, femora narrowed at base. Hind legs reaching 8th segment, similar in shape to the other legs, flatter. Tarsi 3-jointed, longer than tibiæ; claws sharp.

Abdomen as in Æschna, venter flattened, dorsum rounded, largest at 5th segment, tapering toward end. Segments 1 to 9 with strong dorsal hooks. Side-border sharp. Segments 5 to 9 have lateral spines. 9th and 10th ventral segments not hollowed beneath, polished. The three anal appendices rather longer than 10 segment, pyramidal, sharp, of equal length; two lateral ones half as long, blunt, pyramidal.

This nympha is distinguished by highly developed burrowing legs, fore legs strongest; coxæ, femora, and tarsi much developed. Middle legs are nearest together at base, a peculiarity also distinguishable in Gomphoides. Hind legs highly developed. Abdomen exactly like Æschna. Segments of equal length, 10th perhaps a little shorter. Ventral 9th not making part of the hollow of rest of abdomen; stigmata placed outside of hind angles of prothorax. Shape of antennæ and mask refer this nympha to Legion Gomphoides. It might be supposed to belong to genus Progomphus, if that genus were found in New England.

A female nympha not fully grown, 25 mm. length, precisely like foregoing, but darker in color, from Carundahy, Brazil, Thayer Exp., is in the coll., unless some mistake in locality has been made in the label.

10. Gomphoides species.

Selys, Monogr. des Gomph., p. 208.

Pl. I., fig. 5, a, b, c, d.

Nympha, male. Length, 36 mm.; breadth, 6 mm. Skin split, showing the imago.

Locality: Sta Cruz, Brazil. Thayer Exp. Mus. Comp. Zoöl.

Body long, slender. Head cordate, hairy, nearly as broad as the body. Eyes large, prominent. Ocelli well developed. Antennæ rather short, two basal joints globular; 3d twice as long, strong, dilated; 4th short, linear. Vertex flat; in front of anterior ocellus an impression; behind the eyes on occiput an oval depressed spot. Mask reaching half-way between fore and middle legs. Breadth half the length, enlarged in front, middle much produced in semicircular lobe, with fringe of bristles. Palpi short, arcuated, not denticulated; movable hooks longer than palpus and sharp. Prothorax oblong, breadth rather greater than length, sides and angles rounded; two oblique impressions in front and one behind at middle. Wing-cases reaching middle of 4th segment. Legs short, strong, hairy; hind legs more widely separated at base; fore and middle legs of equal size; femora stout and arcuated, enlarged at middle; tibiæ somewhat longer, angular. Tarsi shorter, basal joints very small, 2d longer, knife-shaped, bent outward; claws very small, strong, rather blunt; tibiæ and tarsi have black spines on outer side. Legs formed for burrowing. Hind legs more slender, reaching 6th segment; femora and tibiæ straight; tarsi 3-jointed, 2d shorter than 3d, claws longer, pointed. Abdomen conical, venter less rounded than dorsum, tip extremely tapering. Segments of nearly equal length, gradually decreasing, except 10th, which is longer than 7th, 8th, and 9th together, and nearly cylindrical. Side-edges rather prominent. Segments 7, 8, and 9 have lateral spines. Segments 4, 5, and 6 have dorsal spines, strongest on 4 and 5. Anal appendices pyramidal, short, sharp, all five of equal length. Sexual parts are visible on 2 and 3 ventral segments.

This nympha belongs perhaps to the genus Gomphoides (sub-genus Aphylla) brevipes Selys, the imago of which has the 10th segment of equal length to 9th, while the others, from Brazil, have 10th segment shorter. A nearer determination is not at present possible.

11. Gomphoides species.

There are three female nymphæ, not quite full grown, belonging to a different species, similar to the foregoing and somewhat smaller, differing in having dorsal spines on segments 4 to 9. Locality: Rio dos Macacos, Brazil. Thayer Ex. Mus. Comp. Zoöl.

HAGENIUS.

Selys, Monogr. des Gomph., p. 238.

Body exceedingly flat, nearly circular. Head cordate. Eyes set at back of head. Antennæ very peculiar; two basal joints short, cylindrical; 3d flat, dilated, plate-shaped; 4th very rudimentary, not to be seen unless much magnified. Mask extending to fore legs, square, flat, bent up at sides, front border produced at middle. Palpi small, inner border not denticulated, tip rounded, blunt; movable hook sharp, somewhat longer than palpus. Middle legs more separated at base than fore legs; formed for running. Abdomen very flat, enlarged, nearly circular. The outer edges of segments forming a sharp-edged border, separated from abdomen by marked ventral ridge. 9th segment longer than 8th, 10th small, cylindrical, and entirely inserted in 9th. Anal appendices a little longer than 10th segment.

12. Hagenius brevistylus.

Selys, Monogr. des Gomph., p. 241, No. 86.

Plate III., fig. 4, a, c, d.

Locality: North America. I have seen 8 nymphæ, very young and full grown, length, 12 mm. 40 mm., from Massachusetts, New York, and Osage, Kansas, all females. In the collection of the late Dr. T. W. Harris, in the Boston S. N. H., is preserved the skin of a nympha with the imago raised by him. Coll. Mus. Comp. Zoöl. Coll. Harris. Coll. Hagen.

Body very flat, broad. Head cordate, flat, breadth and length equal; between the antennæ a narrow projection, with rectangular notch at front, inserted in which a cordate tubercle. Eyes situated at hind part of head, moderately large. Antennæ short, broad; the 2 basal joints short, 3d much dilated, flat, circular, with inner edge cut straight; border somewhat elevated, covered with short scale-like hairs; at the

tip a rudimentary 4th joint, only to be seen when much magnified. Vertex flat, ocelli visible. Occiput short, hind-border notched; median line impressed, on each side a small conical tubercle; lateral hind-angles elevated, pyramidal. Mask square, somewhat produced at fore-border. Palpi small, not denticulated, blunt; hook sharp, longer than the palpus. Prothorax narrow, excavated, hind border a little rounded; a transverse impression near fore-border. Legs formed for running, flat, slender. The fore and middle legs short; the fore legs shortest; femora flattened, edged with white hairs; tibiæ angular, longer than femora; tarsi half as long as tibiæ, 2-jointed, basal joint very short. Hind legs long, femora reaching nearly to 7th segment; tibiæ of equal length to femora, tarsi 3-jointed, basal short, 2d longer, 3d equal to both in length. Wing-cases reaching 6th segment. Abdomen lancet-shaped, exceedingly flat, broader than head, nearly circular, dorsum somewhat elevated. Segments of nearly equal length, excepting 10th, which is very small and inserted in 9th. Segments 5 to 6 broadest, the others decreasing, the 9th nearly triangular. The outer edges of segments 2 to 8 form border, sharp and pointed at hind angles. Dorsal hooks prominent, flattened laterally and bent backward, less prominent on 7th to 9th segments. Anal appendices short, stout, pyramidal, blunt, a little longer than 10th segment. Superior somewhat shorter, channelled at sides, lateral very small, half as long as the others. The 8th ventral segment has small bifid vulva lobe.

13. Hagenius (Sieboldius) japonicus.

Selys, Monogr. des Gomph., p. 244, No. 87.

Plate III., fig. 5, c.

Locality: Kanagawa, Japan. Coll. Mus. Comp. Zoöl. One nympha, male, not full grown. Length, 28 mm.

Very similar to *H. brevistylus*, differs as follows: Head a little shorter; hind end of the part between antennæ less deeply notched; inserted tubercle rounded; 3d joint of antennæ not so rounded. Hind angles of occiput blunt. Abdomen straighter at sides, 9th segment shorter; lateral angles of 9th not so sharp. Dorsal hooks modified in flattened tubercles. Anal appendices sharper, superior bluntest, not so deeply channelled at sides; the tip seems to be broken, before the tip are three rounded tubercles; perhaps this is a sexual character; wing-cases reaching to middle of 3d segment only. As a species *Hagenius japonicus* is found in Japan, this nympha is supposed to be the incomplete insect.

14. Ictinus species.

Selys, Monogr. des Gomph., p. 263.

Plate I., fig. 4, a – e.

Nympha, male. Length, 23 mm.; breadth, 10 mm. Locality: doubtful. Coll. Hagen; middle Himalaya, Rev. M. M. Carleton. Coll. Mus. Comp. Zoöl.

Body short, stout, roof-shaped. Head large, cordate, with straight line behind the eyes; the fore part of head, including eyes, triangular, nearly equilateral; part behind the eyes half as long as that before, narrower next the prothorax. Eyes rather prominent, moderately large, triangular; part between the eyes same breadth as eyes. Sides of the head, with small prominent tubercles below the eyes. Ocelli developed. Vertex flat, sloping forward. Antennæ shorter than the head, 2 basal joints globular, 2d half the size of 1st; 3d twice as long as the two preceding, dilated, flat above. At under side of tip a small tubercle, perhaps rudimentary 4th joint. Occiput rather rounded above, sides oblique, hind border notched in middle, hind angles rather blunt. Upper lip stout, broad; base of mandibles heavy, not covered by upper lip; the basal part of head below the mandibles forming a point at each side; basal part of maxillæ not covered by mask. Mask extending between the fore legs, large, nearly square, a little smaller behind; flat, sides bent up; fore-border nearly straight, middle 3d a little produced, slightly denticulated. Palpi short, with bent and rather blunt point, inside finely denticulated; movable hooks long, sharp, arcuated. Prothorax not so broad as head, in general shape semicircular; fore-border forms transverse triangular lobe; hind-border thickened and bent up; the prothorax forms at sides beneath the eyes a protuberance. Meta and mesothorax coming together in elevated ridge. Wing-cases reaching 7th segment. Legs long, slender, formed for running; hind legs more separated at base than the others; femora of fore legs a little arcuated; tibiæ angular, somewhat longer; tarsi $\frac{1}{2}$ as long as tibiæ, basal joints very small, hooks strong and sharp. Middle legs similar, but somewhat longer; hind legs a little longer than the abdomen, straight, flat. Tarsi only two joints, basal very short. Abdomen ovoid, base contracted, broadest at 7th segment, 8th and 9th rounded off toward end of abdomen. Dorsum elevated, roof-shaped. Median line in segments 7 to 9, elevated in flattened hooks, pointed at end of segments. Side-border of abdomen sharp, with lateral spines on segments 7 to 9, similar to Hagenius. Segments 2 to 5 short, following longer; 10th very short and entirely inserted in 9th, sides of segments 2 to 9 with

smooth spots. Anal appendices short, a little longer than spines of 9th segment, pyramidal, sharp, the lateral superior ones a little shorter, the superior middle one with two polished tubercles in the middle of the side-border, perhaps a sexual character. Abdomen beneath hollowed out, but shallow; edges of segments sharply defined.

This larva is extremely interesting. The 2-jointed tarsi of hind legs are exceptions in the whole family; the general shape of body is more like Libellulidæ. The antennæ belong to Gomphus, and the mask also. Stigmata behind prothorax free. The whole body finely granulated. The figure and the description are taken from a dry specimen supposed to be from Brazil (the locality not given), and to belong perhaps to Zonophora. There has just arrived a collection from the middle Himalaya, Sutledge, sent by Rev. M. M. Carleton, containing several specimens in alcohol, all agreeing perfectly with the described specimen. It seems not impossible, indeed probable, that the species belongs to the genus *Ictinus*.

CORDULEGASTER.

Head transverse, oblong. Eyes conical, placed at anterior lateral angles. Antennæ seven articulated, filiform. Between the antennæ the head forms a flat, semicircular projection. Mask extending a little beyond the middle legs, spoon-shaped, covering the mouth, upper lip, and front of head as far as the antennæ. Palpi in general shape triangular, much dilated forward, and furnished at outer edge with long teeth of unequal length, slightly bent inward, and fitting closely in an irregular line into those of opposite palpus; movable hooks short, sharp, slender. Prothorax nearly as broad as head. Stigmata large, quite uncovered. Legs at base widely and equally separated; formed for running. Hind legs shorter than the body. Tarsi 3-jointed. Abdomen cylindrical above, flattened below, tapering at end like a sphinx pupa. Segments nearly equal in length, anal appendices rather long, pyramidal, sharp.

15. Cordulegaster Sayi.

Selys, Synopsis des Gomphines, p. 85, No. 106; second additions, p. 40. Monogr. des Gomph. p. 331, No. 109. — *C. lateralis* Scudd., Proc. Boston S. N. H., X. p. 211.

Plate III., fig. 2.

Locality: Maryland; Cambridge and Chicopee, Mass. July 1–4, 1860. R. H. Wheatland. Length, 40 mm.

Head short, broad. Breadth twice the length, sides straight, rounded off behind so that the hind-border in front of prothorax is half the width of fore-border. Vertex flat. Hind-border somewhat indented. Eyes small, round, prominent, placed at forward lateral angles of fore border of head, with triangular piece projecting inward. Ocelli visible, especially the lateral ones. Antennæ 7-jointed, tapering, slender; the 2 basal joints thicker and more rounded, 3d longer than 2d; joints 3 to 7 form a rather slender seta. Mask large, extending a little beyond the middle legs, triangular, contracted behind; the sides bent up, hollowed back of fore-border, which is prolonged into a bifid tip, surmounted by a short hairy comb. Palpus broad, enlarged at inner border, and deeply denticulated, the denticulations of the opposite palpi closely fitting into one another; movable nook short, sharp, and slender. Prothorax half the length of head, and two thirds the breadth, indented in the middle, raised at fore part in small transverse lobe, at hind part border raised, and thicker in the middle. Stigmata large, open. Legs very hairy, flattened, formed for running. Femora angular, thick, and a little bent; tibiæ about equal in length to femora. Tarsi 3-jointed, more than half as long as tibiæ, 1st joint short, 3d longest: claws very sharp. Hind legs reaching the 7th segment. Abdomen long, rounded above, tapering gradually. Largest part at middle, as wide as head; no dorsal hooks. Segments 8 and 9 with lateral spines. Segments of about equal length. 3 anal appendices of twice length of 10th segment, pyramidal, sharp; superior somewhat shorter; lateral ones very short and sharp. At the end of 8th ventral segment a bifid triangular vulva nearly equal in length to 9th segment.

Have seen one not full-grown female nympha, length 30 mil., from Maryland, which is figured. Coll. Hag., and two full grown from Chicopee, Mass., length 40 mm. Coll. Mus. Comp. Zoöl.

It was thought best to refer this nympha to *C. Sayi*, as this is the only North American species very similar to *C. annulatus*.

16. Cordulegaster annulatus.

Selys, Monogr. des Gomph., p. 333, No. 110.

Plate III., fig. 3.

Nympha, female, not full grown. Coll. Hagen. Locality, Lüneburg, Hannover; Mr. Heyer. Length, 30 mm.

Not to be distinguished from *C. Sayi*, but distinguished from *C. bidentatus* by having lateral spines on 8th and 9th segments, and by the length of superior anal appendix, which is, as in *C. Sayi*, of nearly equal length with lateral appendices. As the only species of *Cordulegaster* known in Europe are *C. bidentatus* and *C. annulatus*, this nympha is referred to the latter; *C. bidentatus* has not been found in the North of Germany.

17. Cordulegaster bidentatus.

Selys, Monogr. des Gomph., p. 339, No. 112.

Plate III., fig. 1, a, b, c, d.

Nympha, female. Raised by Dr. Brauer. Locality, Vienna, Austria. Coll. Hagen. Length, 43 mm.

In most respects strikingly like *C. Sayi;* differs in having the sides of the head more straight, and less gradually sloped backward, making hind-border broader than *C. Sayi;* in having no lateral spines, and in the inferior length of superior anal appendix, which is one half the length of lateral appendices and blunt.

The figured specimen is described at some length by Dr. Hagen, in the *Stettin Entom. Zeit.*, XIV. p. 265, and by Dr. Brauer, *Neur. Austr.*, p. xv.

SYNOPSIS OF THE SPECIES DESCRIBED.

SUB-FAMILY: **GOMPHINA.**

Selys, Monogr. des Gomph., p. 6.

DIVISION I. **INTÉGRILABIÉES.** Selys, Monogr. des Gomph., p. 6.

The under lip entire in the imago.

Head cordate; eyes in the middle of the lateral border of the head; antennæ, 4 articulated, 3d flat, dilated, 4th rudimentary; mask not covering the mouth, nor the upper lip. Legs not equally distant at base; burrowing legs, at least the fore and middle legs; tarsus 2 articulated in the fore and middle legs, 3 articulated in the hind legs, or 2 articulated (Lindenia). Abdomen flattened.

Legio I. **Gomphus.** Selys, Monogr. des Gomph., p. 6.

Mask reaching the fore legs, quadrangular, somewhat longer than broad; palpus hooked at the tip, inside, or denticulated, or with molar incisions. Hind legs farther distant at base than the fore and middle legs, which are equally distant and fitted for burrowing. Abdomen lanceolate.

A. *Front border of the mask produced at middle third in a rounded lobe not cleft.*

Sub-genus: **Herpetogomphus.** Selys, l. c., p. 69. (Supposition.)

1. **H. species.** Nympha, full grown and larva. Brazil, Rio dos Macacos.

Mask, breadth half the length, having two small black teeth on each side of middle of the front-border; palpus finely denticulated. Abdomen gradually narrowing to tip. Segments 2 to 9 with dorsal hooks; lateral spines on 7 to 9; segment 10 a little longer than 9; anal appendices as long as segment 10, the superior a little shorter; the lateral ones half as long as the inferiors.

Sub-genus: **Gomphus.** Selys, l. c., p. 118.

2. **G. pilipes** (or a related species; supposition). Selys, l. c., p. 148.

Nympha, full-grown female. South Carolina, U. S. Mask nearly square; end hook of palpus not longer than the denticulations. Abdomen flat. Segments 9 and 10 very contracted; no dorsal hooks; lateral spines on 8th and 9th segments; segment 10 half as long as 9; anal appendices very short, nearly of equal length, the lateral ones a little shorter.

3. **G. vulgatissimus,** Linné. Selys, l. c. p. 129.

Nympha, full-grown female and male. Europe. Raised by Dr. F. Brauer. Mask quadrangular, front-border middle third finely denticulated; palpus finely denticulated at basal half. Abdomen flat; no dorsal hooks; lateral spines on segments 6 to 9; anal appendices a little longer as 10th segment, the lateral ones a little shorter; lateral spines of 9th segment half as long as 10th segment.

4. **G. fraternus** (or **vastus,** or **fluviatilis,** or **amnicola** Walsh, supposition).

Nympha. Rock Island, Ill. Similar to **G. vulgatissimus.** Segments 8 and 9 with dorsal tubercles; lateral spines of segment 9 longer than segment 10.

5. **G. species.**

Nympha, full grown. Massachusetts. Similar to **G. vulgatissimus.** Spots instead of tubercles on occiput; dorsal hooks but little developed on segments 6 to 9; lateral spines on 7 to 9; segment 9 longer than 8, with lateral spines half as long as segment 10.

6. **G. species.**

Nympha. Pole Creek, Texas. Mask quadrangular, front border of the middle third finely denticulated; palpi blunt, very finely denticulated; abdomen with dorsal hooks on 2d to 9th; lateral spines on 7th to 9th; the lateral spines of segment 9 much shorter than segment 10; anal appendices longer than segment 10, sharp, of nearly equal length.

B. *Front border of the mask produced at middle third in a cleft lobe.*

Sub-genus: **Cyclogomphus.** Selys, l. c., p. 105. (Supposition.)

7. **G. Species.**

Nympha, full grown. Himalaya, Ghugger Pir. Body flat; mask quadrangular, front-border produced at middle third in elliptical lobe, cleft in the middle, with comb of bristles thickened at base; palpus with molar incisions to the end hook. Abdomen flat; no dorsal hooks; lateral spines on 5th to 9th; lateral spine of segment 9 half as long as segment 10; anal appendices a little longer than segment 10, of equal length, sharp.

C. *Front border of the mask cut straight.*

Sub-genus: **Macrogomphus.** Selys, l. c., p. 87. (Raised.)

8. **M. spiniceps** Walsh. Proc. N. H. Soc., Phila., 1862, p. 889.

Nympha, full-grown male and female. Lawrence, Mass. Raised by Mr. Fr. G. Sanborn. Body long, narrow; mask quadrangular, front border cut straight. Abdomen som what conical, tapering; segment 9th twice as long as the foregoing, narrowed in the middle; no dorsal hooks; segment 6 to 9 with lateral spines; anal appendices as long as the 10th segment, which is short and slender, of equal length, pyramidal.

Legio II. **Gomphoides.** Selys, l. c., p. 189.

The general character is not yet given, all species, except one, determined merely by supposition, the determination of some doubtful.

A. *Antennæ with the third joint long, the fourth ¼ length of the third; middle legs nearer at base than fore legs.*

Sub-genus: **Progomphus ?** Selys, l. c., p. 194. (Supposition.)

9. **Progomphus species!**

Nympha, full-grown male and female. Wareham, Mass.; Carundahy, Brazil. There is no genus known to be living in both countries; Progomphus lives in Brazil, though the locality, Massachusetts, is doubtless correct. If the determination is erroneous, as is possible, no other seems more probable.

Body lanceolate; antennæ, 3d joint long, dilated; 4th small, cylindrical, ¼ length of 3d; mask reaching fore legs, long, front-border produced in semicircular lobe, with a comb of flattened hairs; palpi blunt, smooth inside; middle legs nearer at base than fore legs; tarsi knife-shaped, bent up. Abdomen flattened; segments 1 to 9 with dorsal hooks; segments 5 to 9 with lateral spines; anal appendices of equal length, sharp; the lateral ones half as long, blunt.

B. *Antennæ with the third joint long, the fourth very short, linear; middle legs and fore legs equally distant; segment 10 very elongated.*

Sub-genus: **Gomphoides.** Selys, l. c., p. 206. (Supposition.)

10 **Gomphoides species.**

Nympha, male. Sta Cruz, Brazil. Body long, slender: antennæ 3d joint long, dilated; 4th short, linear; mask a little beyond fore legs, long; front border middle third produced in semicircular lobe; palpi hooked at tip, smooth inside; middle legs and fore legs equally distant at base; tarsi knife-shaped. Abdomen long, conical; segment 10 exceedingly long, cylindrical; segment 4 to 6 with small dorsal hooks; lateral spines on segment 7 to 9; anal appendices very short, all of equal length. (An **Aphylla brevipes** Selys?)

11. **Gomphoides species.**

Nympha, female, not full grown. Rio dos Macacos, Brazil. Very similar to the foregoing; dorsal hooks on segments 4 to 9. Perhaps a sexual difference?

C. *Antennæ 3d joint enlarged, circular; body very flat, circular; segment 10 entirely inserted in the 9th.*

Genus: **Hagenius.** Selys, l. c., p. 238.

12. **Hagenius brevistylus.** Selys, l. c., p. 241. Raised by T. W. Harris.
Nympha, female, full grown and young. U. S. Body very flat, enlarged; antennæ 3d joint very flat, circular; 4th rudimentary; mask reaching the fore legs, square, front-border somewhat produced; palpi blunt, smooth inside; fore legs nearer at base than middle legs. Abdomen nearly circular; dorsal hooks and lateral spines on segment 2 to 9; segment 10 very small, inserted in 9; anal appendices short, the lateral ones very small.

13. **Hagenius Japonicus.** Selys, l. c., p. 244. (Supposition.)
Nympha, male. Kanagawa, Japan. Similar to the foregoing. Abdomen straighter at sides; dorsal hooks flattened; superior anal appendix not so deeply channelled at sides.

Legio III. **Lindenia.** Selys, l. c., p. 246.

Sub-genus: **Ictinus.** Selys, l. c., p. 263. (Supposition.)

14. **Ictinus species.** Doubtful determination.
Nympha, male and female. Himalaya, East Indies. Body short, roof-shaped; antennæ 3d joint elongated, 4th rudimentary; mask extending between the fore legs, square, front-border nearly straight; palpi rather blunt, inside finely denticulated; hind legs more distant at base; tarsi of all, 2 articulated. Abdomen ovoid, side-border sharp, denticulated in the males in segment 7 to 9; lateral spines and dorsal hooks in segment 2 to 9; segment 10 very small, inserted in 9; anal appendices short, sharp, the lateral ones a little shorter.

DIVISION II. **FISSILABIÉES.** Selys, l. c., p. 303.

The under lip cleft in the imago.

Legio IV. **Chlorogomphus.** Selys, l. c., p. 311. Unknown.

Legio V. **Cordulegaster.** Selys, l. c., p. 317. (Raised.)

Head transverse, oblong; eyes in the fore corners; antennæ, 7 articulated, filiform; mask extending beyond the middle legs, spoon-shaped, covering the mouth and the upper lip; legs widely and equally separated; tarsi 3 articulated; abdomen more cylindrical, tapering to the tip; the posterior suture of the segments somewhat elevated; anal appendices pyramidal.

15. **Cordulegaster Sayi.** Selys, l. c., p. 331. (Supposition.)
Nympha, full-grown female. Chicopee and Cambridge, Massachusetts; Maryland. Tip of the mask bifid; dentation of the palpus sharp; lateral spines on segments 8 and 9; superior anal appendix nearly as long and sharp as the inferiors; lateral ones very short.

16. **Cordulegaster bidentatus.** Selys, l. c., p. 339. (Raised by Dr. Brauer.)
Nympha, female, full grown. Europe, Vienna. Very similar to the foregoing; head more straight; no lateral spines; superior anal appendix half as long as the inferior, blunt at the tip.

17. **Cordulegaster annulatus.** Selys, l. c., p. 333. (Supposition.)
Nympha, female, not full grown. Europe, Lüneburg. Not to be distinguished from *C. Sayi.*

Legio VI. **Petalura.** Selys, l. c., p. 362. Unknown.

EXPLANATION OF THE PLATES.

PLATE I.

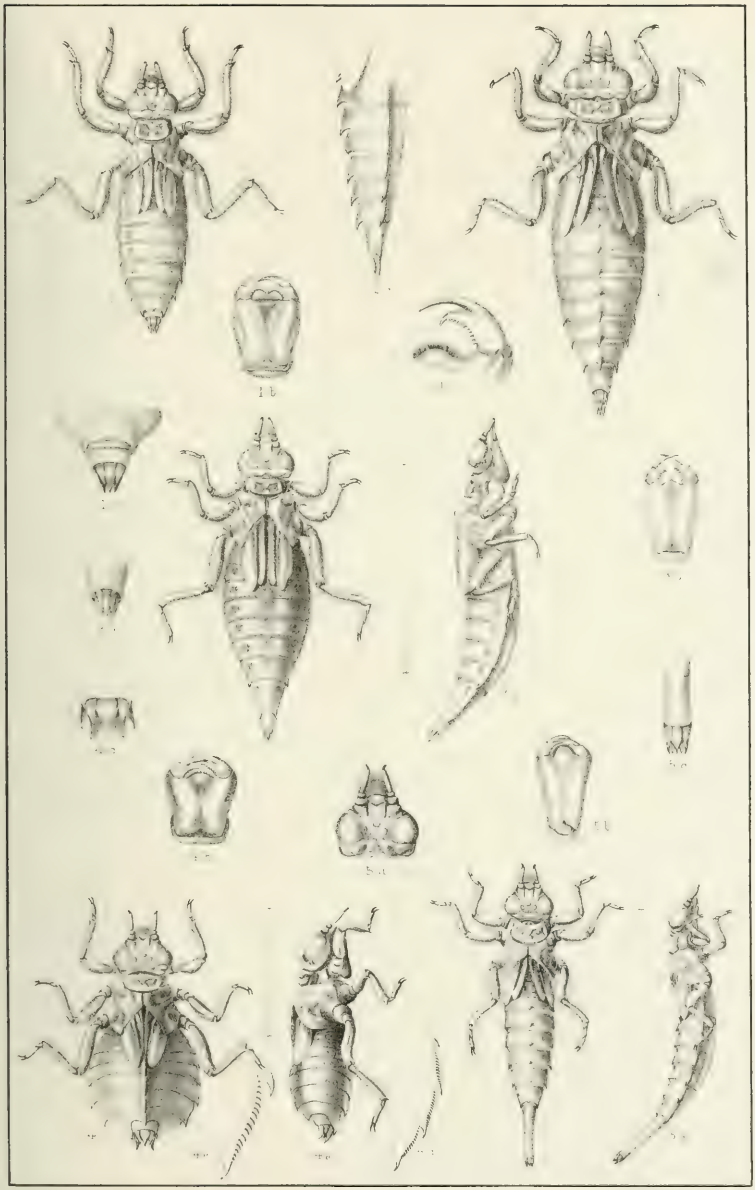
Fig. 1. Gomphus vulgatissimus; *b*, labium; *c*, appendices.
" 2. Herpetogomphus; *b*, labium; *c*, side view.
" 3. Gomphus pilipes? *a*, side view; *b*, labium; *c*, appendices.
" 4. Ictinus; *a*, side view; *b*, labium; *c*, appendices; *d*, lateral border of the abdomen; *e*, the same (the tip) more magnified.
" 5. Gomphoides, species No. 10; *a*, side view; *b*, labium; *c*, appendices; *d*, head.

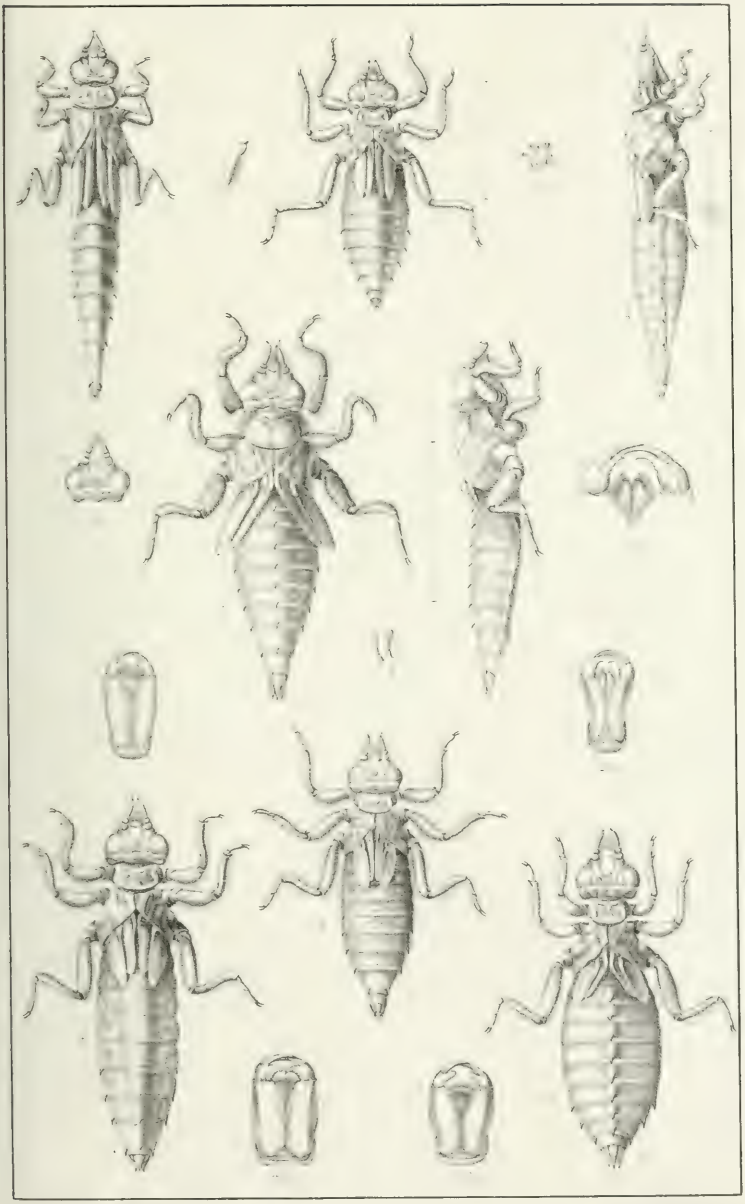
PLATE II.

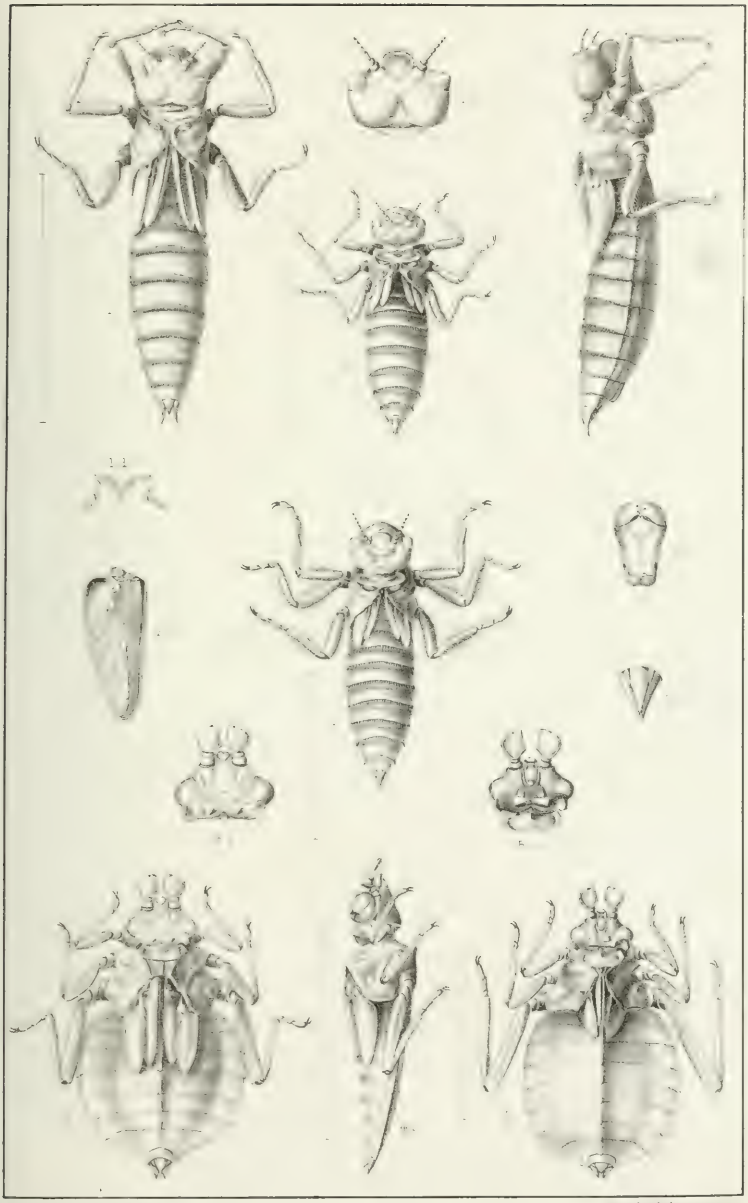
Fig. 1. Macrogomphus spiniceps; *a*, side view; *b*, head; *c*, two last joints of the antenna.
" 2. Gomphus, species No. 7; *b*, labium; *c*, the same (the tip) more magnified; *d*, bristles of the labium border.
" 3. Progomphus? ? *a*, side view; *b*, labium; *c*, bristles of the labium border.
" 4. Gomphus, species No. 4; *b*, labium.
" 5. Gomphus, species No. 5.
" 6. Gomphus, species No. 6; *b*, labium.

PLATE III.

Fig. 1. Cordulegaster bidentatus; *a*, side view; *b*, labium; *c*, head; *d*, bifid tip of the labium.
" 2. Cordulegaster Sayi.
" 3. Cordulegaster annulatus; *b*, appendices.
" 4. Hagenius brevistylus: *a*, side view; *c*, head; *d*, wing-cover.
" 5. Hagenius Japonicus; *c*, head.







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ILLUSTRATED CATALOGUE

OF THE

MUSEUM OF COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE.

No. VI.

SUPPLEMENT TO THE OPHIURIDÆ AND ASTROPHYTIDÆ.

BY

THEODORE LYMAN.

CAMBRIDGE:
PRINTED FOR THE MUSEUM OF COMPARATIVE ZOÖLOGY.
1871.

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Cambridge.

ERRATA.

IN No. I.

Page	9,	5th line from bottom,	*for* Berthelet	*read* Berthelot.
"	10,	13th " " "	" abyssicola	" abyssicolum
"	12,	5th " " top,	" isocanthum	" isacanthum.
"	14,	22d " " "	" Asterochema	" Asteroschema.
"	105,	15th " " "	" Five arms	" Five or six arms.
"	118,	12th, 14th lines from top,	" innermost	" outermost.
"	197,	5th line from top, right column	" Asterochema	" Asteroschema.
"	"	7th " " " " "	" Asteromyx	" Asteronyx.
"	198,	36th, 37th line from top, left column	" 52	" 152.

IN No. VI.

Page	7,	48th line from top	*for* grandisquania *read* grandisquama.
"	8,	10th " " "	" bevispina " brevispina.
"	8,	30th " " "	" Michlin " Michelin.
"	(18)	Description Plates, figs. 1 – 6	" Ophyoglypha " Ophioglypha.

IN the six years that have passed since the publication of the first number of this Catalogue, which treated of Ophiuridæ and Astrophytidæ, our knowledge of these families has considerably increased. Many new species have been discovered, among which the singular forms, brought up by the deep-sea dredgings off Florida, and described in Bulletin No. 10, Vol. I., are of particular interest. In the present Supplement to the Catalogue, figures are given of the most important of these deep-sea Ophiurans; and there are added descriptions of one new genus and of five new species from shallow water. There are given, also, lists of the principal authors, and of the new species described by them, since 1865, making a continuation of similar lists published in Catalogue No. I.

LOUIS AGASSIZ.

October 10, 1871.

PRINCIPAL AUTHORS

SINCE THE PUBLICATION OF CATALOGUE No. I., IN MARCH, 1865.

To which are added some publications not before included. The new species are mentioned with each author.

BRADY & ROBERTSON. Ann. and Magazine of Nat. Hist., III. p. 355.
A notice of Ophianoplus annulosus, Sars, from W. Coast of Ireland.

DUCHASSAING, P. Animaux Radiaires des Antilles. 1850, p. 4.
Ophioderma variegata. (= O. brevicauda Ltk. ?)
" saxatilis. (= Young of O. cinerea ?)
Ophiolepis annulosa. M. T. (No such thing there.)
" trisquamosa.
" vicina.
" albida.
" Tancredi.
Ophiocoma scolopendrina. M T. (No such thing there.)
" serpentaria. M. T. (= O. echinata Agass.)
" crassispina. M. T. (= " " ")
" punctata (= O. pumila Ltk. ?)
Ophiarachna gorgonia. M. T. (No such thing there.)
Ophiothrix fragilis. M. T. (No such thing there.)
" quinquefissa. (= O. orstedii Ltk. ?)
Ophiura hexactinia. Lmk. (No such thing there.)
Euryale costosum. } (= Astrophyton costosum Scba. ?)
" muricatum. }
Trichaster Isidis (= Asteroporpa, Ltk. ? vel Astrogomphus Lym. ?)

I never saw this little pamphlet till recently, and it seems also to have escaped Dr. Lütken's notice. It antedates his descriptions of West Indian Ophiurans by several years; but the short Latin descriptions are so incomprehensible and so vague that I do not think they can be accepted as a basis for priority.

DUJARDIN ET HUPÉ. Histoire Naturelle des Zoöphytes. 1862.
Astroporpa dasycladia. (= Astroporpa annulata.)
Astroschema affinis. (Good sp. ?)

GRUBE, A. E. Über einige seltene oder neue Ophiuriden. Verhand. der Schlesischen Gesellschaft. 1867, p. 22.
Astrophyton lævipelle. (= A. asperum ?)
Ophiolepis adspersa.
Ophiothrix melanostica.
" roseo-cœrulans.
" striolata.
Zeitschrift für die Gesammten Naturwissenschaften, XXX. 1867.
Die Insel Lussin und ihre Meeresfauna. 1864.

HELLER, C. Zoophyten und Echinodermen des Adriatischen Meeres. 1868.
Pectinura Forbesii. Lissa, p. 57.
Ophioglypha Grubei. (= O. albida ?) Lesina, p. 58.
Ophiothrix alopecurus. M. T. He considers different from O. fragilis. p. 63.

HERKLOTS, J. A. Echinodermes de Kuhl, van Hasselt et Sal. Müller. Bijdragen tot de Dierkunde. 1869.
Colored drawings of Ophiomastix annulosa, Ophiolepis annulosa, Ophioplocus imbricatus, Ophiocoma picta, Ophiarachna incrassata, Ophiothrix longipeda, Ophiothrix serrata, K. & v. Has. Good colors, but no details.

Ljungman, Axel. Om nägra nya arter af Ophiurider. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. 1866. No. 6.

Ophiogymna. Gen. nov.
Ophiogymna elegans. Singapore, Hong Kong. p. 163.
Ophiothrix clypeata. Singapore. p. 163.
Ophiactis megellanica. Straits of Magellan. p. 164.
" fragilis. Hawai. p. 164.
Ophiophragmus Loveni. Rio Janeiro. p. 165.
Amphipholis. Gen. nov. (Amphiuræ pars.) p. 165. See Bulletin Mus. Comp. Zoöl., No. 10, Vol. I. p. 335.
Amphipholis Januarii. Rio Janeiro. p. 165.
Ophioglypha Kinbergi. Sidney, N. H. p. 166.

Ophiuroidea Viventia huc usque cognita. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar. 1866. No. 9.

Ophiarachna stellata. Singapore. p. 305.
" spinosa. (= Ophiopeza fallax? See Ltk. Addit. III. 36.) Foua Is. p. 305.
Ophioglypha multispina. Sidney. p. 307.
" Tenori. Mediterranean (Ophiura, Delle Chiaje). p. 308.
Ophiopus. Gen nov.
" arcticus. Spitzbergen. p. 309.
Ophionereis squamata. Honolulu. p. 310.
" crassispina. Honolulu. p. 311. (See Bulletin Mus. Comp. Zoöl., Vol. I., No. 10, p. 312, note.)
Amphipholis (vel Amphiura) depressa. Deep sea between Batavia and Singapore. p. 312.
" " " integra. Port Natal, S. Af. p. 313.
" " " hastata. Mozambique. p. 313.
" " " grisea. Gulf of Guayaquil. p. 313.
" " " impressa. Deep sea between Batavia and Singapore. p. 314.
" " " albida. (= A. Januarii?) Rio Janeiro. p. 314.
" " " subtilis. (= A. Januarii?) Rio Janeiro. p. 314.
" " " lobata. Near Sidney, N. H. p. 314.
Ophiophragmus antarcticus. "In fretu Magalhaënsi." p. 315.
" gibbosus. Port Natal, S. Af. p. 316.
" echinatus. Sea between Batavia and Singapore. p. 316.
Amphiura divaricata. Deep sea between Batavia and Singapore. p. 318.
" Eugeniæ. Atlantic, opposite river La Plata. p. 318.
" candida. Near Mozambique. p. 318.
" complanata. Atlantic, off Rio Janeiro. p. 319.
" crassipes. " " " p. 319.
" flexuosa. Near Brazil. p. 319
" verticillata. Galapagos Islands. p. 320.
" capensis. Near Port Natal and Cape of Good Hope. p. 320.
" magellanica. Straits of Magellan. p. 320.
" latispina. Atlantic, off river La Plata. p. 320.
" atlantica. Near St. Helena. p. 321.
Ophiocentrus. Gen. nov.
" aculeatus. Deep sea between Batavia and Singapore. p. 321.
Amphilepis. Gen. nov.
" norvegica. Norway. p. 322.
Hemipholis affinis (H. gracilis VII.) Guayaquil. p. 322.
Ophiactis (?) Savignyi (Ophiolepis M. T.) Egypt. p. 323.
" carnea. Port Natal, S. Af. p. 324.
Ophiacantha indica. Deep sea between Batavia and Singapore. p. 326.
Ophioscolex purpurea. Düben and Koren, Norway. p. 327.
Ophiocnemis obscura. Straits of Malacca. p. 333.

Tillägg till kännedomen af Skandinaviens Ophiurider. Öfvers. af K. Vet.-Akad. Förh. 1864. No. 7, with a plate.

Ophiocten sericeum Ljn. (= Ophiura sericea Forbes. = Ophiocten Kroyeri Ltk.) p. 360.
Amphiura tenuispina. (= Amphiura squamata, var.?) p. 360.
" norvegica. Norway. p. 363.

LJUNGMAN, AXEL. **Ophiactis** clavigera. S. Norway. p. 365.
Om tvänne nya arter Ophiurider. Öfversigt af Kongl. Vetenskaps Akademiens Förhandlingar. 1870. No. 5.
Ophiacantha vivipara. Atlantic, near E. Patagonia. p. 471.
Ophioglypha Lymani. " " " p. 472.
LORENZ, J. R. Physikalische Verhältnisse, etc. der Organismen in quarnerischen Golfe.
LÜTKEN, C. F. Additamenta ad Historiam Ophiuridarum. Part III. 1869, from the Vidensk. Selsk. Skr.
Ophionepthys. Gen. nov.
Ophionepthys limicola. St. Thomas. p. 98.
Ophionema. Gen. nov.
Ophionema intricata. St. Thomas. p. 98.
Amphipholis fissa. Amur. p. 98.
Ophioconis. Gen. nov. (= Pectinura Heller.) (O. Forbesii.) p. 98.
Ophiopsammus. Gen. nov. (= Ohiopeza Yoldii.) p. 98.
Ophiochœta. Gen. nov.
Ophiochœta setosa. Feejee Islands. p. 98.
Ophiarachna affinis. " " p. 98.
Ophiomastix mixta. Samoa Islands. p. 99.
" asperula. Feejee Islands. p. 99.
" caryophyllata. Feejee Islands. p. 99.
Ophiomyxa australis. Between Australia and Tasmania. p. 99.
Ophiocoma canaliculata. " " " " p. 99.
Ophiacantha pentacrinus. (= O. meridionalis Lym.) W. Indies, deep sea. p. 99.
Ophiothrix striolata. Grube. New Guinea and China Sea. p. 99.
" elegans. China Sea. p. 100.
" trilineata. Samoa Island. p. 100.
" capensis. Cape of Good Hope. p. 100.
Asteromorpha. (Gen. nov.)
Asteromorpha Steenstrupii. Unknown. p. 100.
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DESCRIPTION OF NEW SPECIES.

OPHIOMAZA.* Gen. nov.

Teeth. Tooth-papillæ numerous, and arranged in a close vertical oval, as in *Ophiothrix*. No mouth-papillæ. Disk below naked, but covered above with large, swollen radial-shields and plates. Arm-spines stout, nearly smooth, as in *Ophiocoma*.

This curious genus has the dentition of *Ophiothrix*, the disk of *Ophiocnemis*, and the arms of *Ophiocoma*.

Ophiomaza cacaotica. Sp. nov.

Plate I., fig. 15.

Special Marks. — Five, sometimes six arm-spines, the two or three upper ones considerably largest. No tentacle-scale. Interbrachial plates on back of disk elongated and irregularly broken.

Description of a Specimen. — Diameter of disk, 11$^{mm.}$; from outer side of mouth-shield to outer corner of opposite mouth-slit, 4.2$^{mm.}$; distance from outer side of mouth-shield to inner points of tooth-papillæ, compared to that between outer corners of mouth-slits, 2.5 : 2. Width of arm, 2$^{mm.}$; length of arm about 30$^{mm.}$; tooth-papillæ small and crowded, about 26 to each angle of the mouth; four strong, square-edged teeth. Under arm-plates, beyond edge of disk, broader than long; their laterals and inner side slightly re-enteringly curved; outer side slightly curved; length to breadth (6th plate), 9 : 1.2. Within the disk there are six plates, of which the one next the mouth-slit is small and oval; those outside of it grow gradually broader and are shaped like those beyond the disk; side arm-plates stout, but not much projecting; upper arm-plates broader than long, somewhat irregular, broader without than within, outer side curved; length to breadth (8th plate), .9 : 1.6. The first two or three plates are narrow and wedge-shaped and fit in a notch in the disk; beyond the margin they grow wider, and have their

* Ὄφις, serpent; μάζα, a cake.

full width at the 7th or 8th plate; disk naked below and covered by thick, wrinkled skin; radial shields very large, pear-seed shape, length, to breadth, 4 : 2.5, separated by a band of three or four elongated, narrow, broken, and irregular plates, which come to the edge of the disk, and are continuous with the upper arm-plates. Interbrachial spaces covered by plates similar in form to those between radial-shields, but wider; in the centre, a rosette of small, very irregular pieces, one in the middle, and five close around it. The edge of the disk has a row of stout, swollen plates, three to five in each interbrachial space, of which one is opposite the radial-shield on either side, and from one to three are opposite the interbrachial plates. Arm-spines usually five sometimes six; the two or three upper ones much the longest; all stout, tapering, blunt, cylindrical; lengths, to that of the upper arm-plate (7th joint), 2.2, 2, 1.6, 1, 1, .5 : .9. Near end of arm, three or four spines, of which the under one is much swollen at the base, and slightly hooked at the end. Color, in alcohol: deep chocolate. Zanzibar, collected by Mr. Cooke.

Ophiothela tigris. Sr. nov.

Plate I., figs. 10, 11, 12.

Special Marks. — Back of disk completely covered by the radial-shields, which are quite smooth, as are also the interbrachial spaces below. Five arms.

Description of a Specimen. — Diameter of disk, $7^{mm.}$; length of arm (which had been repaired), $12^{mm.}$; from outer corner of mouth-slit to outer edge of opposite mouth-shield, $3^{mm.}$; width of arm, including side arm-plates, 2^{mm}; distance from outer corner of mouth-shield to points of tooth-papillæ, to that between outer corners of mouth-slits, 1.6 : 1.5. Tooth-papillæ arranged in a close, vertical, oval clump; about fifteen in number; four stout, flattened, squarish teeth, which with the tooth-papillæ form a dentition like that in *Ophiothrix* (a generic character); mouth-shields irregular, sometimes in form only of a small swelling; but, when clearly defined, having an oval heart-shape, with outer side straight, and with length to breadth, .5 : 1. Side mouth-shields large and conspicuous; their free lateral sides re-enteringly curved; their inner laterals joined along their whole length; their inner sides making together a wide curve; under arm-plates covered with thick skin and seen indistinctly, except when dry. They have an irregular triangular form, with a peak within and a lumpy surface. They cover only a part of the arm, and differ in figure one from another. Side arm-plates

standing out independently, as pad-like ridges (a generic character), which are stout and swelled; upper arm-plates represented by a double row of irregular elongated warts, which just at the base of the arm are increased in number, so as to form a clump of different-sized pieces. At the tapering end of the arm there are still the two warts at the base of each joint, and between these a double row of fine grains. Disk wholly covered above by the ten great radial shields, which are regular, slightly swelled, and smooth; at the insertion of the arm and in the interbrachial space they form a slight notch or re-entering angle. Interbrachial spaces below covered with thick skin, without spines or scales; genital-slits with a large prominent scale at their outer end, whose edge can be seen from above. Arm-spines like little stumps, thorny at their ends; towards the end of the arm they become more flattened, and the three lowest ones are armed with three or four flattened hooks. The first joint outside the mouth-shield has two or three spines on each side; the second three, and the rest four. Color, in alcohol: upper surface lined and marbled with dark green and light yellow, interbrachial spaces below dark green; under surface light greenish.

Another specimen had a disk of $5.5^{mm.}$, and arms of $18^{mm.}$. The mouth-shields were all regular, except the madreporic, which was swelled. The back of the disk had a central pentagon of marbled bluish and yellow, surrounded by a band of yellowish. The animal doubtless has the power of *moving* the side arm-plates, which in this specimen were folded close on the arm.

Locality unknown, but supposed to have been brought from the Pacific by the Exploring Expedition.

Ophiocnida Putnami.* Sp. nov.

Plate I., fig. 9.

Special Marks. — Nine or ten flat arm-spines, the upper ones with broad ends; they closely cover the arm, as if with grains of rice regularly set in rows. Disk beset with similar, but smaller spines. Two swelled papillæ at the apex of the mouth-angle. Two tentacle-scales.

Description of the Specimen. — Diameter of disk, $16^{mm.}$. Width of arm, $2.5^{mm.}$; length of arm about $72^{mm.}$. From outer side of mouth-shield to outer corner of opposite mouth-slit, $4.8^{mm.}$; distance from outer corner

* Named after the late Captain W. H. A. Putnam, a man of a fine taste in natural history, and who enriched this Museum with remarkable collections made during his sea voyages.

of mouth-slit to inner point of mouth-papillæ, to that between outer corners of mouth-slits, 2.2 : 2.4 ; mouth-shields small, rounded, narrower without, length to breadth, 1.1 : .8 ; side mouth-shields small and not meeting within ; two large swelled mouth-papillæ at the inner apex of the angle ; they are pressed close together and present a re-entering grinding surface ; above, and partly covered by them, a swollen irregular tooth, followed by three more which are squeezed together and more or less thickened ; above these again are four flat, square-edged teeth separated from each other, the uppermost are longest. Outside each mouth-papilla stands the thick, club-like tentacle-scale of the first mouth-tentacle ; above which, and nearly hidden in the mouth-slit, is the tooth-like scale of the second mouth-tentacle. Under arm-plates small, nearly square, with slightly re-entering sides ; length to breadth (9th plate), .8 : .8. Upper arm-plates small, nearly round, but farther out on the arm, the inner side is straight ; length to breadth (12th plate), .8 : .9. Arm-spines 9 (near base of arm 10), white, flattened, upper ones broadened towards the end, like a narrow spatula ; lowest one broadest and stoutest, next two or three above it narrower than the rest ; length of uppermost, .8$^{mm.}$; 7th, 1.2$^{mm.}$; lowest, 1$^{mm.}$ towards point of arm, 5 or 6 spines which are flat and taper to a blunt point. No tentacle-scales ; tentacles large and long. Disk puffy and lobed, covered above and below with fine, regular scales, about 60 to a square ^{mm} ; beset above and below with numerous stout, flattened, spines, .8$^{mm.}$ long, and resembling the arm-spines. Radial-shields small, inclining to crescent-shape, separated and standing just over base of arm ; length to breadth, 2.6 : 1. Color, in alcohol : disk gray ; arms straw color.

Collected, almost without doubt, at Hong Kong, by Captain W. H. A. Putnam.

This handsome species is an *Amphiura* with a thorny disk ; and I therefore place it in *Ophiocnida*, as an approximation to its natural position, without asserting that its affinities are thus exactly expressed. See Bulletin of the Mus. Comp. Zoöl., Vol. I. p. 335.

Ophioglypha sinensis. Sp. nov.

Plate I., figs. 1, 2.

Special Marks. — A pit or depression between the side arm-plates, on the under side of the joints within the disk (as in *O. lacertosa*). Only one tentacle-scale on most of the pores beyond the disk. An arm-comb along the edge of the radial-scale, but none on the arm itself.

Description of a Specimen. — Diameter of disk, 9mm.; from outer corner of mouth-slit to outer side of opposite mouth-shield, 4.2mm.; distance from outer side of mouth-shield to point of innermost mouth-papilla, to that between outer corners of mouth-slits, 2 : 2; width of arm, 1.4mm. Mouth-papillæ, six to each angle, whereof the two outer ones on each side are thin and triangular, and the innermost is stouter and more elongated, approaching the form of the teeth, which are four in number, stout, and formed like a blunt spear-head. Mouth-shields large, "lyre-shaped," that is to say, bounded by a curve without, an angle within, and by re-entering curves on the sides; so that the inner corners, at the heads of the genital-slits, make little peaks: length to breadth, 1.7 : 1. Side mouth-shields very narrow, meeting within, and running along inner angle of mouth-shield to its corner, where they run across the head of the genital-slit to the side arm-plate. Under arm-plates small, much wider than long, with an angle within and a curve without. This is their general form, except that the first two or three are squeezed laterally; length to breadth (8th plate), .2 : .5, a little way out they become very minute. Side arm-plates large, meeting below along a line longer than the under arm-plate; those within the disk are indented at their juncture, making a little pit. They make a re-entering curve where the tentacle-scale is fixed, and at little peak between it and the under arm-plate. Upper arm-plates strongly arched, wider without than within; bounded by straight lines on the sides and by a curve without; length to breadth (8th plate), .6 : .8. Disk covered with larger and smaller irregular scales, among which may be seen the larger, round, primary plates. Radial-shields pear-seed shape, nearly or quite touching without; length to breadth, 1.3 : 1. Radial-scales carrying a close comb of rounded tapering papillæ, in form like the arm-spines, which grow smaller as they pass below the disk and end in a row of fine grains, midway the genital-slit. Arm-spines, three, slender, rounded, regularly tapering, not quite so long as the joint; length to that of under arm-plate (8th joint), .8, .7, .7 : .2. Tentacle-scales thin and nearly round. On the first pair of great pores, three or four on each side; on the second and third, three on one side and two on the other; on the fourth, two on one side and one on the other. The next four or five pores have one large scale, and a very small one, which last stands on the side arm-plate. Color, in alcohol: straw yellow.

Collected, almost without doubt, at Hong Kong, by Captain W. H. A. Putnam.

Variations. — All the specimens had broken arms, but by their character they had probably about the proportions of *O. Sarsii*, say a length of three or four times the diameter of the disk. There were two specimens in which the side mouth-shields were broader; the pits on

the under side of the base of the arm, little marked or wanting, and no little peak in the under arm-plate next the tentacle-scale. Perhaps another species, perhaps only a variety.

O. sinensia looks a good deal like *O. lacertosa* of Europe, but is distinguished by wanting the additional comb of papillæ on the base of the arm, and in having fewer tentacle-scales.

Ophiomastix janualis. Sr. nov.

Plate I., figs. 13, 14.

Special Marks.— Disk-scales conspicuous below, but obscured by thick skin on the upper surface of disk, which is beset with sharp tapering spines; but none below. Three round tapering arm-spines, the uppermost longest.

Diameter of disk, 5.5$^{mm.}$; arm nearly cylindrical, 1.2$^{mm.}$ wide; very slowly tapering to a length of 24$^{mm.}$, where it is broken off. From outer corner of mouth-slit to outer side of opposite mouth-shield, 2.5$^{mm.}$; distance from outer side of mouth-shield to inner points of tooth-papillæ, to that between outer corners of mouth-slits, 1.2 : 1.5. Tooth-papillæ four, arranged in a close clump, directly below the teeth, which are as in *Ophiocoma*. Mouth-papillæ, 8, arranged in a close half-circle round the mouth-angle; outer ones flat, rounded, as long as broad; inner ones narrower and smaller. Mouth-shields longer than broad, narrower within than without, angles rounded; length to breadth, .9 : .6. Side mouth-shields triangular, lying along the sides of the mouth-shields, but not meeting within. Under arm-plates wider without than within, with a little peak without, and their sides a little re-enteringly curved; length to breadth (6th joint), .6 : .5. Farther out, the plates become more elongated, with a clean curve without, re-entering sides, and a truncated angle within. Side arm-plates projecting but slightly; at base of arm they meet neither above nor below, but, at the 11th upper arm-plate, they meet above. Upper arm-plates wedge-shaped, with a curved outer side, and laterals re-enteringly curved; length to breadth (6th plate), .7 : .6. Disk finely scaled in the interbrachial spaces below, each about $\frac{1}{8}^{mm.}$ long; above the scaling is covered except near the edge, round the radial-shields, and at the base of the arm, to which it extends. Scattered over the upper surface are a few sharp spines, 1.5$^{mm.}$ long, which are mounted on slight elevations and stand over the places of the primary plates. The radial-shields project close to the arm as little, irregular, triangular, swellings about .7$^{mm.}$ long. Arm-spines three, rounded, slightly tapering, blunt;

under a lens, finely grooved; lengths (5th joint), 2.3, 2, 1.2. Tentacle-scales usually two, of which the outer is nearly oval, the inner small, narrow, and tooth-like. Color, in alcohol: chocolate brown, dappled with yellowish.

Mexillones, Bolivia; Captain Putnam.

As to the genus of this specimen, it may be called a spiny *Ophiocoma*, or an *Ophiomastix* wanting the club-shaped arm-spine. Müller & Troschel, in characterizing *Ophiomastix*, say (Syst. Asterid., 107), "Disk beset with scattered spines. . . . On the arms, above the spines, club-shaped bodies running out at their ends into several projections"; and their original, *O. annulosa*, has a fine imbricated scaling, from which stand out little naked radial-shields. Lütken (Addit. ad Hist. Oph., Pt. III. p. 26) has shown that the club-shaped spine is not a constant feature in the genus, which therefore is hardly to be set off from *Ophiocoma*, and that, moreover, the disk may be beset either with spines of various sorts, or with spines and grains. With the addition of this species, his view of the genus would stand thus: —

A. Disk smooth or with very few short spines,	*O. venosa* Pet.
B. Disk closely beset with grains and moderately long spines,	*O. mixta* Ltk.
C. Disk densely beset with very short spines,	*O. asperula* Ltk.
D. Disk on both sides beset with long thin spines,	*O. annulosa* M. T. *O. caryophyllata.* Ltk.
E. Disk beset on its upper surface, only, with slender spines; arm-spines all slender and tapering,	*O. janualis* Lym.

The species under A, B, C, and D all have certain of the arm-spines either club-shaped or forked at the end, but that under E has no thickening of these spines.

NOTE ON NOMENCLATURE AND CLASSIFICATION.

Dr. Lütken, in a foot-note on page 68 of his Additamenta (Part III.), remarks: 1. That names prior to Linnæus have no place in present nomenclature. 2. That, when an author has described a species, his name must always be put after that species as the authority, no matter if the *generic* name be *changed*. As to the first of these propositions, I may say, that Linnæus first contrived what is called binomial nomenclature, in which each animal has two names, the generic and the specific. Consistency is the first duty of a naturalist, therefore it was the first duty of the followers of Linnæus to respect and to adopt such binomial names as may be found in ante-Linnæan authors, of whom some were among the most celebrated of zoölogists. When, then, I find the name *Astrophyton costosum* distinctly used by Seba (III. Pl. IX., Fig. 1, p. 16, 1758), and moreover an excellent figure given, I shall certainly apply that name to the West Indian species to which it belongs. Did not

Seba, more than a century ago, publish a fine folio, with figures that are better than some of those we see nowadays, and shall we ignore his names when they are such as may properly be taken? In putting such a name as *Ophiopholis bellis* for *Ophiopholis aculeata*, I think I have gone too far, because the name *bellis* of Linck is used as part of a diagnosis and not as a name. I was, however, encouraged in the selection by the usage of Johnson and of Forbes.

As to the second point, Dr. Lütken expresses great astonishment, "after all that has been written," that anybody should change the *authority* with each change in the *combination* of a name. For instance, we have, in 1854, *Ophiura nodosa* Ltk. I afterwards attempted to show that *Ophiura* was preoccupied, and made a name, *Ophioglypha*, to take its place; and the question now is, Shall it be written *Ophioglypha nodosa* Ltk. or *Ophioglypha nodosa* Lym.? Dr. Lütken has no cause for astonishment. There are two parties to this question. That to which he belongs insists on considering *credit* or *honor* the real reason for using names of authors; and always speaks of the "injustice" done when an author's name is lost sight of. The party whose views I hold maintains that nomenclature is *a system of exact registration*, and that, with the present enormous mass and confusion of titles, no other guide is possible; and further, that the credit of a zoölogist does not rest on his monogram, but on something better. Will the reputation of John E. Gray be greater because his name thus appears often; or will that of Lacaze-Duthiers be less because his appears seldom? After what I have said in the Bulletin (Vol. I. p. 336, note), I can add nothing more to the point than a quotation from Alexander Agassiz (American Naturalist, Vol. V. p. 354): —

"The history of the present confused condition of nomenclature is an interesting one; it is the attempt to show by the binomial system, not only the correct name of any animal, but, at the same time, give a short historical sketch of the changes the name has undergone. The name of an animal or plant is that binomial combination which it has first received, let us say *A b* from Linnæus; [*A* (generic) *b* (specific)]. Subsequent changes, such as the transfer of this to a different genus, *B*, by Cuvier, are simple matters of registration, a part of the *history of the science*, showing what Cuvier thought of the affinities of the species named *A b* by Linnæus. When, then, we speak of this species as *B b* Cuvier, we are recording his views as an investigator, and this does not lessen whatever credit there may be in the original description of *A b* by Linnæus. If afterwards Blainville comes and says that Cuvier should have referred *A b* to the genus *C* of Latreille, and quotes this species hereafter as *C b* Blainville, he is only recording his opinion, and so on through indefinite time. *Changes which the progress of science render necessary in the position of A b of Linnæus are or should be quoted under the*

authority of the author who proposes them as expressing the actual condition of our knowledge of the affinities of the species A b of Linnæus."

At any rate, let the decision be what it may, Dr. Lütken need have no fear that his own reputation rests on any such unstable basis. To sum up. *Astrophyton costosum* Seba. and *Ophioglypha nodosa* Lyman. mean just what they should mean, and nothing more; to wit, that in the writings of these two persons will be found these names definitely, used for the *first time*. They do not distinguish these persons as good or as poor zoölogists, nor do they show that such names are the correct ones; but they are simply the "trade-marks" of workmen.

As to the "Synopsis" of *Ophiuridæ* presented by Dr. Lütken (l. c. p. 87), I have no objection to it, provided it be understood as a movement towards a true classification, or as a really convenient tabulation of genera. But inasmuch as it rests on the structure of the mouth parts it cannot be expected to be an exposition of nature, any more than can a classification of fishes based on their scales; of mammalia, on their nervous centres; or of molluska, on the character of their shells. Any one who will examine the single original genus *Amphiura* will be convinced how impossible it is to arrange it only on the *number* of the mouth-papillæ. In fact, the species of *Ophiuridæ* are now so numerous, that some one man must examine them all with his own eyes, before we can hope for a good arrangement. And especially do the genera *Ophiocoma* and *Ophiothrix* need severely to be weeded.

DESCRIPTION OF THE PLATES.

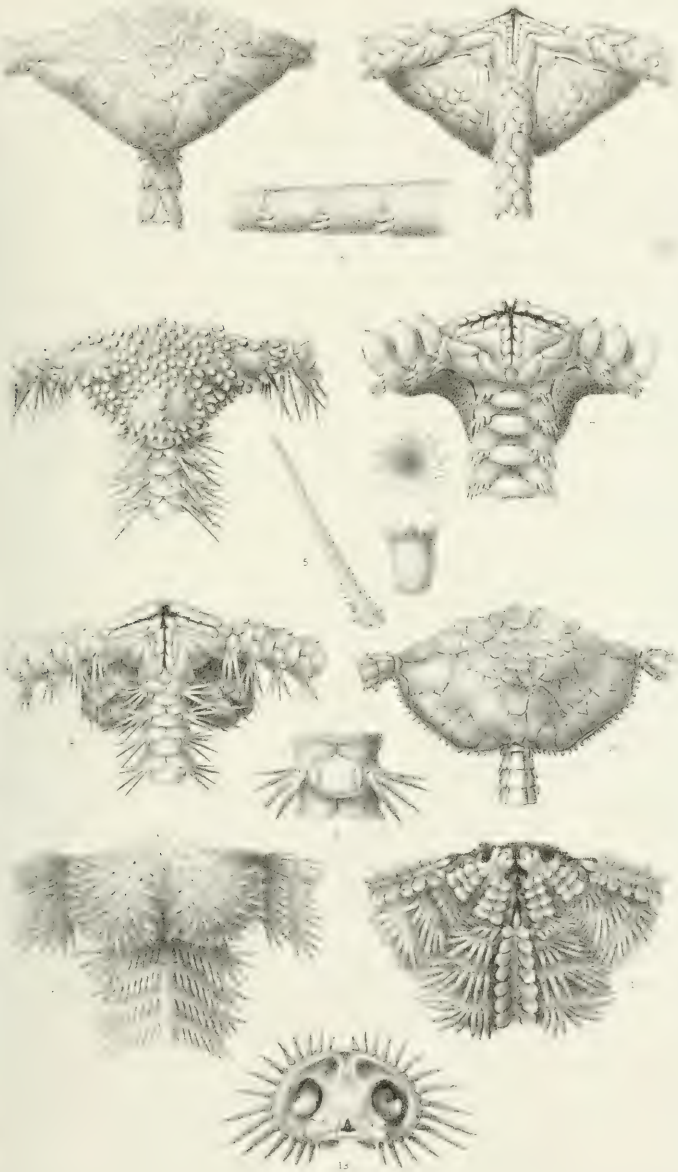
These are all alcoholic specimens; but, in drawing them, the spirit was allowed to evaporate, so that the details could be properly seen.

PLATE I.

Fig. 1. Ophioglypha sinensis.
" 2. " " under side of sixth arm-joint, to show the position of the tentacle-scales.
Figs. 3, 4. Ophioglypha falcifera; arm-spines of the basal joints.
Fig. 5. " " base of the arm in profile, with edge of disk and comb of papillæ.
" 6. Ophyoglypha acervata; under side of an arm-joint. (The lobe on the outer side is not made distinct enough.)
" 7. Ophiocnida olivacea.
" 8. " " under side of an arm-joint showing the spine-like tentacle-scale.
" 9. Ophiocnida Putnami. The little organs at the outer corners of the mouth-slits are the mouth-tentacles.
" 10. Ophiothela tigris.
" 11. " " enlarged view of the parts near the mouth, and of the first and second under arm-plates, and the first set of arm-spines.
" 12. Ophiothela tigris. One of the pad-like side arm-plates bearing its arm-spines.
" 13. Ophiomastix janualis.
" 14. " " under side of an arm-joint, showing the small and great tentacle-scales.
" 15. Ophiomaza cacaotica.
" 16. Astrogomphus vallatus.
" 17. " " first sets of arm-spines magnified; *a*, head of the genital-slit.
" 18. " " a piece near the tip of the arm, highly magnified, showing the granulations on the arm-joints, and the ridges of larger granules, between the joints, on which stand the hooks.
" 19. Ophiocreas lumbricus.
" 20. " " an angle of the mouth seen from within, showing the column of teeth, and on each side a bunch of granules or small papillæ, beyond which appear the two pairs of mouth-tentacles.
" 21. Ophiocreas lumbricus; an arm-joint showing the thorny arm-spines.

PLATE II.

Figs. 1, 2. Ophiomusium eburneum, from above and below.
Fig. 3. " " arm from the side.
" 4. Ophiomitra valida.
" 5. " " an arm-spine.
" 6. " " thorny stumps from the disk.
" 7. Ophiochondrus convolutus.
" 8. Ophiothamnus vicarius.
" 9. " " an arm joint from below.
" 10. Ophiocten depressum.
Figs. 11, 12. Ophiomyces frutectosus, from above and below.
Fig. 13. " " arm-joint in section showing the retracted tentacles and the arrangement of the arm-spines.



P Hoetter on stone from nat.

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VOL. II. No. 9.

ON SOME INSECT DEFORMITIES.

By DR. HERMANN A. HAGEN.

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NOTE.

The quarto publications of the Museum will hereafter be issued under the title of "Memoirs of the Museum of Comparative Zoölogy." In order not to commence a second series, the numbers of the Illustrated Catalogue already issued have been combined to form the first volumes of these Memoirs. Title-pages and tables of contents of the three volumes already completed are sent with the present number.

ALEXANDER AGASSIZ.

ON SOME INSECT DEFORMITIES.

In arranging the Lepidoptera of the collection, I found, among the insects brought home from Brazil by Professor L. Agassiz, a specimen of *Morpho Eurylochus* with the head of the caterpillar. The excellent condition of the large specimen induced me to compare all published observations of a similar deformity. These are few, and scattered in transactions not easily accessible. Therefore I concluded to reprint the full text for the two oldest known, and to give copies of the figures, together with those of *M. Eurylochus*. In the hope of having information about other similar cases, I published a provisional paper in the Stettin Ent. Zeit. (1872), p. 388, and I am indebted to Professor Zeller of Stettin, Professor Westwood of Oxford, Mr. M'Lachlan of London, and Dr. J. L. Leconte of Philadelphia, for additional information.

The rare and less known paper of Mr. C. Majoli, on a precocious development of *Bombyx Mori*, and the notice of two deformities of Coleoptera, seemed to me not out of place in this paper.

PERFECT INSECTS WITH THE LARVAL HEAD.

Phalæna heteroclita.

The well-known Danish naturalist, Professor O. F. Mueller, has described (1764) in his Fauna Fridrichsdalina, p. 47, No. 413, a new species of Noctua, found by himself at Fridrichsdal, a locality a few miles distant from Kopenhagen.

Phal. N. heteroclita suberistata, capite erucæ, antennis nullis: alis albis, lineis transversim undatis punctatisque marginalibus nigris. In Epilobio.

This description is verbatim, repeated by himself in his Prodromus Faunæ Danicæ (1776), p. 124, No. 1428.

In the Mém. de Mathém. et de Phys. présentés à l'Acad. R. des Sciences à Paris (1774), Vol. VI, pp. 508 – 511, pl. 1, Professor O. F. Mueller has given a detailed account of this most remarkable speci-

men, believing it to be a new and very curious species of Lepidopteron, with all the characters of the order, except that the head is exactly that of a caterpillar. In the same volume of the Mémoires, the editor (Préface, p. 8) believes it more prudent not to admit Mueller's insect as a new species, because a fact contrary to all hitherto known must be proved by a great number of observations before it can be adopted by the scientific world. Professor Beckmann, the reputed polyhistor from Goettingen, in his Physik. Oekon. Bibliothek, Vol. VI. p. 338, believes that Mueller's insect is only a deformity. A review of Mueller's paper in the Comment. Lipsiens. (Vol. XXI. p. 466) I have not seen.

The French paper is translated by the Rev. J. A. E. Goeze, in the 16th part of the Naturforscher (1781), pp. 203–212, pl. 1. The plate is of course the same as Mueller's plate, but somewhat inferior in execution. The translation, in some places at least, does not entirely agree with the original, as Goeze introduces some suppositions to explain more fully Mueller's words, which are not everywhere free from ambiguity. But it is to be remembered that Goeze had spoken of the whole with Mueller, at a visit paid to him by the latter in 1776. At that time the type was still present in the collection of the author, which was afterwards destroyed at the bombardment of Kopenhagen. In my Bibliotheca Entom. (Vol. I. p. 556) I stated that the insect was *Bombyx dispar*, which is apparently an error. Westwood (Introd., Vol. II. p. 356) calls it one of the Noctuidæ; and Lacordaire (Introd., Vol. II, p. 442), une Noctuelle. The insect is not mentioned in the general works of Borkhausen and Ochsenheimer, but Werneburg (Beitr. zur Schmetterl. kunde, Vol. I. p. 376), quotes it as *Bombyx monacha*, and there is no doubt that this determination is a correct one.

Mueller found the insect alive, quietly sitting on a stem of *Epilobium montanum*, on July 28, 1762, pinned it, and only became aware at home of the remarkable fact that the head of the caterpillar was still existing on the moth. Both Mueller and Goeze give as the date June 28, apparently erroneously, as in the paper it is twice stated that the insect lived ten days on the pin, until the 6th of August, when it died. From June 28 to July 6 there are only nine days.

The description by Mueller is as follows:

Nearly the size of *Phal. vinula;* upper wings white, with several transverse zigzag lines, the border spotted with black; hind-wings smaller, grayish, the border with alternate black and white spots; all the wings blackish underneath, the border spotted with black; abdomen black, somewhat hairy, with five yellow rings, which are broad above, narrower beneath, and twice interrupted; the tip of the abdomen pointed, yellow, with a yellow ovipositor; the prothorax densely covered with white hairs, sprinkled with black; the thorax with four legs, black and gray-colored; the tibia with two spurs on the inside.

"La tete" (I give purposely Mueller's words), "cette étrange partie, est grisâtre et arrondie, plate au devant; elle est composée, comme le sont ordinairement les têtes de chenilles, de deux lobes latéraux, grisâtres et pointillés en noir, lesquels se joignant par-dessus, laissent au milieu une figure triangulaire et brune. C'est une membrane mince, qui à l'aide d'une loupe, laissait entrevoir une liqueur transparente, agitée d'un mouvement continuel. Il y a au bas du triangle deux petits corps ovales, qui avancent sur deux organes noirs, lesquels se répondent exactement et se choquent, au milieu de l'embouchure, comme deux marteaux. On voit à côté deux organes émoussés de couleur jaune, qui dans les chenilles sont communement garnis d'un poil fin, ce qui manque ici; plus bas, il s'avance des côtés deux crochets coniques et jaunâtres qui se touchent au milieu de la bouche; à l'entour on voit quelques taches incarnates et grandes; plus a coté quelques points brillants et par-ci par-là quelques petits brians de poils."

The moth lived ten days, and deposited a number of green eggs, most of them on the first and second days, some on the latter days up to the 6th of August, when it died. The eggs were not developed.

Mueller repeats a second time (p. 511): "On voit clairement le mouvement peristaltique de la liqueur sous la membrane triangulaire, aussi bien que le mouvement des organes de la bouche; il ne s'en trouve pas la moindre trace des antennes et trompe."

It would not be justifiable to consider this statement pure and simple an error, inasmuch as Mueller was undoubtedly one of the most prominent naturalists, and must have known very well the importance of the described facts. If the statement of Mueller is accepted as correct, the specimen is an exception, and differs considerably from all others as yet recorded. It must have been an imago, with the head of the caterpillar preserved; not only with the skin covering the head of the imago preserved, but with a real head of the caterpillar, in which the circulation of the blood is still taking place, and the maxillary organs are still movable. Such a condition of the parts is contrary to all our present knowledge of the anatomy and the development of insects. It is remarkable that the forelegs have not been developed, as the superior part of the prothorax is similar to that of the imago. But Mueller records and figures only the four posterior legs.

The opinion of Mueller, that his moth represents a new and somewhat intermediate genus and species, is of course an erroneous one. The supposition by Kirby and Spence, Introd., Vol. III, p. 121 (transl. Oken), that the head was damaged perhaps in the caterpillar state by some parasite, and the caterpillar therefore was unable to cast off its skin, needs no refutation. I cannot give any probable explanation of the fact; perhaps it was a monstrosity, never observed but in this isolated specimen.

Mueller's observation was accepted by the prominent naturalists of the time, — for instance, by Bonnet. Later J. F. Meckel (Handb. der pathol. Anatom., Vol. I, p. 55) explained the fact as an arrested development of the insect. Dr. Stannius (Mueller's Archiv., 1835, p. 296) accepts this explanation. J. van der Hoeven (Tijdskr. voor natuurl. Gesch., Vol. VII, p. 274) believes the case to be just like that of Wesmael and rejects the opinion of Mueller concerning the head; but I think he has not given strict attention to Mueller's statements.

Nymphalis Populi.

Professor Wesmael gives in Bull. Acad. Bruxelles, 1838, Tom. IV, p. 359, reproduced partly in Ann. Scienc. Nat., Ser. 2, Vol. VIII, p. 191, a description and colored figure of this insect. If I am not mistaken, I saw, in 1870, the type in the Museum in Brussels. He caught the specimen in July, near this city. The insect had the thorax, abdomen, legs, and wings perfectly well developed and colored, but with the head of the caterpillar. The insect turned the curious head to the right and left, and tried, by a quick motion of the forelegs, to push it off. Mr. Wesmael, in dissecting the left side of the head, discovered underneath the external skin a second one much thinner than the first, and beneath the second one the well-developed eye of the butterfly. The parts around the eye were covered, as commonly, with scales. Therefore Wesmael considers the second skin as that of the chrysalis, and believes the deformity originated by the inability of the caterpillar to cast off the head.

Underneath the head of the caterpillar, and just above the skin of the chrysalis, was the left antenna, coiled up, but without an apical knob. The antenna was covered by a very fine membrane, which was to a great extent diaphanous, and transversely striated with brown. The left palpus was free, normally developed, and turned horizontally backwards. The right palpus seemed broken off; the place of its insertion was clearly visible. Mr. Wesmael says nothing about the prothorax; as the forelegs were free and movable, it must have been without any covering.

This butterfly differs essentially from the moth described by Mueller. The head shows only the skin of the caterpillar, which really has gone through the transformation into the head of the chrysalis, and later into the head of the imago, retaining throughout the skin of the former stages, one above the other. The recorded movement of the head was apparently done by the movement of the head of the imago. Wesmael makes the following conclusions: —

1. The insects which are obliged to undergo transformation may have only a partial one, which does not prevent the total transforma-

tion of other parts; even if the untransformed parts are important to the life of the animal. He believes this to be a natural consequence of the segmentation of the body of the arthropods.

2. The accidentally covered parts nevertheless go through all transformations which are necessary for the insect to arrive at the imago state. The second conclusion is of course not to be accepted, if the facts recorded by Mueller are adopted.

Morpho Eurylochus.

Among about a dozen specimens of this butterfly brought home by Professor L. Agassiz from Brazil, one male has retained the head of the caterpillar. The specimens are from Canta Gallo, communicated by Dr. Teuscher. Their perfect condition leads me to suppose they were reared from the chrysalis.

The quoted male is in perfect condition, and, as all others, entirely well developed in size and in colors. The head of the caterpillar is retained and perfectly preserved in shape and in color; the minute yellow hairs which cover the head are in good condition, and the spines are scarcely crumbled. Beneath the head the mentum is broken off near the prothorax. Its lateral sutures are separated, and the mentum hangs down as a kind of trap-door, being united with the head only by a small anterior lobe. This kind of adjustment leads me to suppose that the mentum was broken by the pushing out of the spiral tongue of the imago. The opening is large enough to show that the head of the caterpillar is empty inside. The skin between the head and the prothorax is still preserved in the shape of a contracted ring, which is open only for a small space beneath, where the mentum is separated. The large dorsal plate of the prothorax is present, and covers loosely the thorax of the imago; on the left side the external third is wanting. The palpi are rejected to the thorax, but the right palpus has the two basal thirds covered by the skin of the caterpillar, which is connected with the dorsal part of the prothorax. Behind the palpus and rather near to it can be seen the free foreleg of the right side. Its limbs are well developed, neither as stout nor as hairy as in the other specimens. The left palpus, though not covered, seems to be shorter and less hairy than the right one. The left foreleg is covered by the femur of the middle leg. I am not able to state whether any part of the skin of the chrysalis, either beneath the dorsal plate of the prothorax on the middle and on the right, or on the entirely free left side of the thorax, is present. Perhaps the skin of the chrysalis is broken off just at the ring formed between the head and the prothorax. I am unable to see the skin of the chrysalis inside of the head of the

caterpillar through the small opening of the mentum. As the skin of the chrysalis must have existed, I did not deem it necessary to dissect the specimen, especially as Wesmael's dissection of *Nymphalis Populi* has sufficiently explained the fact.

The head of the caterpillar resembles very much the figure in Merian Surinam. Lepid., pl. 23. The color is leather-yellow, with two brown bands on each side. There are two yellow finger-shaped horns on the top, and three similar ones on each side; they become successively smaller. The last one is very short.

The specimen has doubtless lived long enough to get the colors perfectly developed, and to break down the mentum with the spiral tongue. It differs from Wesmael's butterfly in having retained the dorsal part of the prothorax, though somewhat distant to allow a view of the thorax of the imago. In Wesmael's butterfly the palpi were not covered. I have quoted erroneously, in the Proceed. Bost. Soc. N. H., 1868. Vol. XII. p. 163, the Brazilian specimen as *Morpho Iliones*, and Mueller's specimen as *Dicranura vinula*.

Vanessa Antiopa.

Professor Zeller has described in the Isis, 1839, p. 259, a specimen with the head of the caterpillar, raised by himself together with about 150 others. The specimen differs from them only by the presence of the head of the caterpillar, which is in a vertical position, just as in the caterpillar. The mouth is closed. Having cut a part of the left side, the Professor could observe a hollow space between the head of the caterpillar and the remaining parts of the insect. Behind the head and not connected with it the two anterior plates of the chrysalis are retained. The butterfly made its transformation in the absence of the Professor, and was pinned at the same time with all the others. It was impossible to find its chrysalis skin.

Vanessa Atalanta.

Mr. Bond exhibited in the Entomological Society in London, February 6, 1871, a specimen bred by a metropolitan collector, which still bore the larval head. The specimen, as I am informed by Mr. M'Lachlan, was very perfect.

Pieris Rapæ.

Among a number of chrysalids which had not transformed, I found in the fall of 1871, in Cambridge, one of an extraordinary appearance. In casting off the skin of the caterpillar only the thoracic part of the

chrysalis was developed; the head of the caterpillar was still present, but its sutures were separated. The dorsal split of the skin reaches the first segment of the abdomen, and the skin of the abdomen is retracted, but still present.

A similar specimen was observed last fall by Mr. S. H. Scudder.

Zygæna exulans var. Vanadis.

Dr. Staudinger, in a paper on the Lepidoptera of Lapland in Stett. Entom. Zeit., 1861, Vol. XXII. p. 359, records a larval-headed male of this species, found, July 11, near Bossekop. The specimen is fully developed, with the head of the caterpillar. The mouth parts were immovable in the living insect; the head was fastened to the prothorax, and moved only by the motion of the prothorax. The latter is fully developed beneath, and with its legs; above there is a horny black vaulted ring, somewhat hairy on the left side. Mr. Staudinger believes it impossible that the head of the imago is enclosed in this larval head.

Sphinx spec.

Mr. Trouvelot assured me that he had caught in Cambridge several years ago, a Sphinx with the head of the caterpillar. The specimen is no longer in existence.

Professor Van der Hoeven, in his quoted paper, p. 274, records that he has seen a caterpillar of *Sph. Tiliæ* which had not been able to cast off in the last moult the skin covering the spine of the tail. The caterpillar died before the transformation.

Bombyx Mori.

Mr. J. J. Bruinsma, in Tijdschrift voor Natuurl. Geschied, 1840, Vol. VII. pp. 257–270, pl. 1, has published detailed observations concerning the same deformity, accompanied by figures.

Having read Wesmael's paper, Mr. Bruinsma concluded to try his own observations in raising silk-worms. In the course of the summer he found some specimens, which did not agree exactly with Wesmael's butterfly, but seemed interesting for publication. But shortly after Mr. S. Van Leuwen, also interested in the same kind of observations, communicated to him, August 9, a chrysalis with the upper part of the larval head still remaining. The chrysalis was fourteen days old, and had been taken out of a cocoon, in which the skin of the caterpillar was found. The skin showed nothing unusual, except that the head, which commonly remains united with the skin, was broken off.

The chrysalis was of medium size, rather lively, and perfectly developed. To the upper part was fastened with a collar the caterpillar's head, split in two lateral parts, which are united together in the common caterpillar head. The mouth parts of the caterpillar were still remaining, but between them another prolongation could be seen. The nympha is figured in different views, Figs. 1 – 4.

The chrysalis transformed, August 26, into a moth with the caterpillar head. The chrysalis had the skin split as usual on the dorsal part. So the moth left the chrysalis in the usual way, and was perfectly developed (Fig. 5), except that the right foreleg was smaller than the left one, but otherwise well formed. Therefore the moth stood somewhat obliquely. It was a male, rather lively in his movements, and used both forelegs to push off the caterpillar head, by which it was seemingly annoyed. The head of the caterpillar covered exactly the place where the head of the moth should be, so that nothing was to be seen of it, nor of its antennæ or eyes. On the prothoracic border the same elongated part was to be seen as in the chrysalis, without any hairs, consisting only of a brownish membrane The side parts of the head were fastened to it just as in the chrysalis. The right part was taken off, and beneath it the right antenna was discovered, well formed, but coiled up. In taking off more of the skin, a well-formed eye of the perfect insect appeared.

Mr. Bruinsma explains the fact by the difference of the last moult from the four preceding ones. He states that in the last moult the skin splits near the tail, and the chrysalis comes out backwards, by which process the head is sometimes not able to follow. I confess that this statement is entirely new to me, and disagrees with Malphigi's description.

Mr. Bruinsma concludes his paper with some observations made on caterpillars which, after having spun the cocoon, were taken out and obliged to spin a second cocoon. This was only imperfect, so that a full observation of the caterpillar was possible. Mr. Bruinsma observed that one of them formed a chrysalis with the head of the caterpillar. But the chrysalis died very soon. Two of the caterpillars are figured.

Professor J. Van der Hoeven has published a paper in the same journal, following that by Mr. Bruinsma, pp. 271 – 275, about perfect Lepidoptera with the larval head remaining. He draws attention to an old observation by J. Jonston, published in his Hist. Natur. de Insectis, Amstelod, 1657, p. 123 (Edit. Heilbr., 1768, p. 176). The account by J. Jonston is very detailed, and concerns a male and a female of *B. Mori*. The male was in the chrysalis state, the anterior part covered with the parts of the caterpillar. The imago was not able to cast off the skin, died. and was dissected. The head of the imago was found to be fully developed.

The female showed perfectly well the head of the caterpillar, and beneath it the skin of the chrysalis, containing the head of the imago.

"Itaque ibi senectæ caput [head of the caterpillar], nymphæ vertex et necydali [imaginis] conjuncta conspiciebantur; quæ conjunctio retinebat senectam [skin of the caterpillar] in ventre, ne potuerit potius avelli et destringi. Ideo et cohærebat, cum alvi acumine, non aliter ac si quis sacco fuit inclusus; et circa caput astrictus; facto vero in tergo foramine dorsum extraxisset quidem, sed adhuc hæreret capite et podice, ita jacens incurvus et exanimis. Sic habebat senecta (the caterpillar]. Ex hac prominebat et aurelia [chrysalis], quod attinet partem superiorem. Ex aurelia vicissim necydalus [imago] fere totus eluctatus erat, fracto putamine in dorso, solitaque regione; sed capita cohærebant indivulsa, sicut et alvi extrema. In ventro exorto magna copia ovorum conspiciebatur colore flavo."

The statement of the skin of the caterpillar split on the dorsum disagrees with the statement by Mr. Bruinsma.

Professor Van der Hoeven (ibid., p. 274) communicates, in a letter to Mr. A. Brants, November 26, 1839, that Mr. Einodhven, in his silk-worm nursery at Brummen, Holland, had observed several times imagines with the head of the caterpillar. Mr. Brants was able to take out of one of them the perfectly developed head of the imago. The antennæ were coiled up, covering the eyes of the insect.

Mr. Bond exhibited in the Entomological Society in London, February 20, 1871, a specimen of *B. Mori* retaining the larval head. The specimen was somewhat crippled and very small, as I am informed by Mr. M'Lachlan.

Gastropacha quercifolia.

A specimen with the larval head is recorded by Professor Westwood in Entomol. Month. Magaz., No. 82, p. 239.

Zerene adusta.

I am indebted to Professor Zeller for the details of this. Among a number of caterpillars of this species, one transformed in a chrysalis, with the head of the caterpillar. The chrysalis died, perhaps because it was kept too dry. Otherwise probably a moth would have been reared, as the chrysalis was perfectly developed. The head of the caterpillar was in perfect condition, but placed so far beneath that the chrysalis had a hunchbacked appearance. The face and the ventral side met in an acute angle; a collum was wanting, but the head was round, separated more deeply below. As all parts of the head of the chrysalis are covered by the head of the caterpillar, there are no an-

tennal covers visible. The furrow in which the antennæ should have been placed begins very shallow on the prothorax, near the head, and runs between the front margin of the anterior wings and the hind legs, somewhat longer on the right side. This furrow is largest along the tibia. The covers of the palpi and the tongue are wanting.

Botys fuscalis.

Mr. Stainton exhibited in the Entomological Society in London, a specimen with the head covered by a part of the puparium, caught on the Isle of Man. It was flying briskly when captured, and was otherwise perfectly developed. The antennæ and the haustellum were free, and the case of the latter projected downwards like the rostrum of a Panorpa. I am indebted to Mr. M'Lachlan for the communication of this case.

Of insects not belonging to Lepidoptera, only four with a similar deformity are known.

Cybister limbatus.

Mr. Smith (Proceed. Entom. Soc., London, Ser. 2, Vol. IV, p. 34) exhibited a specimen with the larval head, caught swimming near Hongkong in China.

Dytiscus marginalis.

Professor Westwood (the Entom. Month. Mag., No. 82, p. 239) stated that he had seen a specimen with a larval head.

Hydaticus bimarginatus.

I am indebted to Dr. John L. Leconte for the information that a specimen of this beetle, with the larval head, is in the collection of Dr. Helmuth in Chicago.

Syrphus spec.

Professor Westwood (ibid.) states that he had observed one specimen with a larval head.

I am indebted to the same professor for the communication that he is about to publish a dozen cases of perfect insects with the larval head, all of which he has figured.

The specimens mentioned above are: —

Lepidoptera. — 1. Vanessa Atalanta.
2. Vanessa Antiopa.
3. Nymphalis Populi.

4. Pieris Rapæ.
5. Morpho Eurylochus.
6. Zygæna exulans.
7. Sphinx spec.
8. Bombyx Mori (several times).
9. Liparis Monacha.
10. Gastropacha quercifolia.
11. Zerene adusta.
12. Botys fuscalis.

Coleoptera. — 13. Dytiscus marginalis.
14. Hydaticus bimarginatus.
15. Cybister limbatus.

Diptera. — 16. Syrphus spec.

Only the fact of the presence of the larval head is known for the Nos. 7, 10, 13 – 16. More or less sufficient details are known for Nos. 1, 3, 8, 12, but the publication by Professor Westwood will give doubtless a full information about them. The Nos. 4, 11, were only in the chrysalis state, and do not strictly belong here. But just those cases are interesting, as all the others must have passed the chrysalis state in the same manner.

The Nos. 1, 2, 8, and probably 5, were bred by home raising; Nos. 3, 6, 7, 9, 12, 15, were caught living.

The interesting fact that the larval head is sometimes retained in the perfect insect is proved by the quoted observations. Probably all cases except *Noctua heteroclita* belong to the same kind of deformity. The head of the imago is contained in the head of the larva, which the insect was not able to cast off in the transformation. It must be admitted that circumstantial details are known only for *V. Populi*, *V. Antiopa*, *M. Eurylochus*, *Z. exulans*. The prothorax of the two last-mentioned species, and even one foreleg in *M. Eurylochus*, is still covered by the larval skin. The antennæ are free in *B. fuscalis;* the palpi are rejected in *V. Antiopa*, *V. Populi*, *M. Eurylochus;* in *Z. exulans* they are free. All specimens were fully developed in size, shape, and colors, except *B. Mori*.

Perhaps such deformities are not so rare as the small number of known cases would lead us to believe. Such deformed specimens are more easily caught and destroyed by their natural enemies, or they die sooner for lack of food. Nevertheless, the very large number of Lepidoptera bred and raised during the past hundred years allows us to conclude that at least in home raising such deformities occur very rarely. Mr. Trouvelot observed many times *T. Polyphemus* caterpillars casting off the larval head with more or less difficulty, and sometimes not at all. The last case proved to be fatal. As insects of course are developed more easily in liberty than in captivity, the rare occurrence of perfect

insects retaining the larval head may depend on the larger mortality of their caterpillars.

There is very little known concerning the physiological and mechanical processes shortly before or during the act of transformation of arthropods. Nearly all entomological works state that the larvæ moult or change their skin several times, that the larvæ become restless some days before the change, stop eating, and desert their food; later, the skin splits, and the insect perfects its transformation.

I believe there exist few men who have not seen and observed once in their life this wonderful spectacle. The proceedings are so common, and always so easily performed, that observers are not induced to think about the manner in which transformation is effected, nor about the mechanical acts providing the possibility of such a change. Concerning the mechanical acts, so far as I know, nothing is published. An animal, or even a man, covered with an artificial skin well fitted to the whole body, obliged to go out of the skin through an aperture made of similar size and relation as that in insects, would scarcely be able to do it without a violent use of the limbs. Insects use their limbs very little or not at all in the beginning of transformation, but nature has provided some help in the necessary coincidence of certain physiological proceedings just at the time of transformation.

I have observed many times and in different insects, before transformation, a very accelerated and excited action of the dorsal vessel. The same fact is recorded by other observers, for instance by Mr. Weismann and Mr. W. Blasius. After observations of Mr. W. Blasius (Zeitschr. f. wiss. Zoöl., Vol. XVI, pp. 135 – 177), during the transformation of the caterpillar into the chrysalis, the action of the dorsal vessel increases successively in the first three hours, and reaches its maximum in the last half of the fourth; after that time the action begins to decrease, and becomes in the eighth hour equal to the action in the third hour. The consequence of an accelerated action of the dorsal vessel is an increased circulation of the blood, going from the tail to the head. This sudden rush of an unusual quantity of blood to the head and the thorax, without any corresponding arrangement for convenient emanation, swells those parts, pushing them forward at the same time. Finally the skin bursts, and one of the most important acts of the moult is performed.

I suppose that the frontal bladder, which is observed in transforming Diptera and Odonata, is the consequence of the rush of blood; nevertheless, an observation recorded by Weismann seems to disagree with such a supposition. It should not be overlooked that some other purely mechanical proceedings seem to accompany and help the propulsion of the insect by the rush of the blood in a very easy manner. I have described long ago a related fact in regard to the moult of Ephemera.

Stettin. Ent. Zeit. (1849), p. 365. The segments of the abdomen possess on each side an apical spine. By a continuous movement of the abdomen to the right and left, those spines press successively against the loosened skin, forcing forward the transforming insect. Probably similar arrangements will be found in other insects.

The causes why such a rush of blood originates just at the time of the moult, I find nowhere recorded. I think it not sufficient to consider it as a simple consequence of an action of the nervous system, especially as I believe myself able to give a more plausible explanation.

The crust of insects consists of the external chitinized epidermis, and the internal soft hypodermis. Above the latter, which becomes somewhat separated from the epidermis, the new skin is to be formed, at first without impediment to the functions of the insect. As long as the more or less isolated parts of the new skin allow a free circulation of the blood around and between them to feed the old epidermis, the action of the dorsal vessel follows its regular way. By and by the isolated parts of the new skin become larger, and partly united, until finally the whole new skin is already formed and chitinized. The circulation is at first only disturbed; later, it is impossible for it to flow in the old way and to the old skin, and the blood, obliged to turn in another direction, rushes naturally in the easiest one, to the dorsal vessel. This is the moment of the beginning of the rush of the blood to the head; of course the nervous system, irritated by the rush, will help to accelerate more the action of the dorsal vessel.

It is obvious that the new skin, at least in some parts of the body, must exercise a more or less strong pressure against the old skin. I am of the opinion of Dr. Gerstaecker, that the moult is not alone a consequence of such pressure; but in some parts, for instance in the head, the pressure is obviously prevalent, and must originate a partial resorption of the old epidermis, as that of the thicker sutures. At least, thus the splitting of the sutures in many insects could be explained; I say purposely in many insects, because a large number transform in a different way. In some Lepidoptera the skin of the head does not split. Mr. Trouvelot (Americ. Natur., I, p. 37) records for *Telea Polyphemus* that the skin splits transversely under the neck just at the end of the head, and perhaps in some way laterally, and probably behind or through the whole prothorax. "When about one half of the body appears the shell of the old head remains like a cap enclosing the jaws; then the worm, as if reminded of this loose skull-cap, removes it by rubbing it on a leaf."

I was able to verify Mr. Trouvelot's observation on a cast-off skin of *T. Polyphemus*. However, in the nearly related species *Att. Cecropia*, *Prometheu*, *Yama-mai*, I found that the sutures of the head always split in the regular manner. According to Kirby and Spence, the manner of

splitting is not the same for all Lepidoptera. Most of them split at first the dorsum of the second and third segment of the caterpillar. *Pieris crataegi* is stated by Bonnet to split its skin only in the head; and Reaumur records for *Zygæna filipendulæ* that the caterpillar bites off pieces of the old skin and puts them aside. Besides those old observations there exists a large number of recent ones. Generally it is true that Coleoptera, Orthoptera, Pseudoneuroptera, Diptera, Hemiptera, at least the Homoptera, and the larger part of Lepidoptera, split first the frontal sutures of the head.

It is of interest that the well-known *Limulus Polyphemus* splits in the moult the frontal sutures similar to the insects, and goes out forward of the old skin. I find nothing published about the splitting of the skin of the Crustacea. But the Decapods split along the border of the cephalophorax, and are obliged in moulting to take out the parts backwards. As the systematic position of Limulus is still a matter of dispute, I think this fact is of some value.

The restlessness of the insects before the moult, and the fact that they do not need food, are easily understood. It is known that the tracheæ participate largely in the moult. At certain times the inner skin must begin to separate, and it is obvious that through it the respiration will be impeded. Perhaps this difficulty has something to do with the acceleration of the blood. Besides the tracheæ a large part of the digestive canal changes its skin; the anterior part to the ventriculus, and the posterior to the colon. Here also, at a certain time, the inner skin begins to separate, and the natural consequence will be the impossibility of taking any food, or even of ejecting the superfluum contained in the intestines.

All insects, as I stated before, go forwards out of the old skin in transformation. But I find one case of the contrary quoted by Professor Westwood (Brit. Cyclop. Article Insect, p. 844). He says that Coccus comes out backward, the wings rejected above the head.

A very remarkable fact is that the females of the Ephemerous genus Palingenia do not change the skin of the subimago. Swammerdam says the females for the most part do not change the skin; but a very large number of them examined by myself possessed the subimago skin, and I never saw one without it. They undergo copulation and lay eggs without having arrived at the state of a perfect insect.

The instances where insects in the last moult are not able to throw away the skin and carry it with them are in Ephemera not very rare, as the long setæ are sometimes fastened in the old skin. But I caught a Libellula flying with its nympha skin fastened to the end of the abdomen. The specimen, *Diplax scotica*, is still in my collection. I am indebted to Mr. A. Agassiz for a knowledge of the fact that larvæ of Radiates are sometimes found with parts of the foregoing state still attached to the skin.

ON THE PRECOCIOUS DEVELOPMENT OF THE CATERPILLAR DIRECTLY INTO THE IMAGO STATE.

Bombyx Mori.

Mr. Cesare Majoli, in Giornale di Fisica, Chemica, Storia Naturle del Regno Italico di L. Brugnatelli, Pavia, 1813, Bim. V, p. 399, describes a curious instance of a precocious development of the well-known silk-moth. The book seems to be wanting in all libraries of the United States, and is not even common in Europe. I am obliged to Professor Pelzel in Vienna, Austria, for a written copy of the notice, which I find recorded only in J. F. Meckel's Archiv f. Physiol., 1816, Vol. II, p. 542, and in Lacordaire's Introd., Vol. II, p. 443, and by Stannius in Mueller's Archiv, 1835, p. 297. As both differ from each other in some important statements and from the text, I prefer to reprint the original.

Straordinario fenomeno di anticipata trasformazione in farfalla del verme da seta.

Il Sign. A. Farini di Forli ha communicato al Sign. Barzoni un' osservazione interessante descritta dal Sign. Lettore Cesare Majoli in un opusculo M. S. sulla vita, costumi ed educazione del filugello. Sovente aveva sentito raccontare da chi educava i bachi da seta, che pure qualche volta accadeva svolgersi essi in farfalla prima che incominciassero a filare il bozzolo, cioè dopo la quarta muta. Le reputava favole femminili, giacchè nissuno aveva parlato di un tale fenomeno. Ma si è convinto del fatto nel 1792, allorchè chiamato a rendere ragione di esso trovò che due cannicci e stuoje di bruchi erano isfarfallati nella notte antecedente senza formare il bozzolo deludendo cosi la speranza del coltivatore. In qualcuno degli anni antecedenti accadde pure un somigliante fenomeno, e nel 1811 il Sign. Dott. Siboni gli mandò due di questi aborti volanti generati in una casa di proprietà della Signora Rosatti che lo stesso Sign. Farini ha osservato. Questa farfalla differisce dalla falena bombice per li seguenti caratteri. Ha il capo piccolo, due occhj neri reticolati, il torace quale se fosse il terzo anello dopo il capo del bruco; ha il corpo del bruco istesso all' epoca della quarta muta, pari numero di anelli a quello del bruco; le ali superiori alquanto lunghe e ristrette, le inferiori più corte e strette; ha le antenne alquanto cenerognole in confronto di quelle della falena vera bombice. Il Sign. Majoli espone una conghiettura sopra la cagione del fenomeno mentovato e inclina ad attribuirlo al calore eccessivo del luogo in cui esistevano què bachi da seta, per cui nel momento in cui filugello sta

per compiere la sua metamorfosi dello stato di bruco, ne altera siffattamente il sistema primitivo, ne promuove una traspirazione straordinaria de' fluidi esistenti nel bruco e soprattutto di quello che è necessario a formare il bozzolo, e ne acceleri così la sua metamorfosi d' isfarfallare. Sarebbe stato a desiderare che per confermare in qualche modo l' accennata opinione si fosse tentato artatamente di attenere lo stesso effetto col sottoporre diversi bruchi ad una temperatura calda, allorchè erano vicini alla quarta muta. Interessante sarebbe il sapere se le farfalle che abortirono avevano gli organi della generazione ben formati e capaci come la falena bombice di accoppiamento e di mettere le uova atte a sviluppare a suo tempo il bacolino.

[TRANSLATION.]

An extraordinary case of a precocious transformation of the caterpillar of Bombyx Mori into the moth.

Mr. A. Farini, in Forli, has communicated to Mr. Barzoni an interesting observation, published by Mr. Cesare Majoli, about the life, the manners, and the education of the silk-moth. He was told by men occupied with the breeding of silk-worms that it sometimes happens that caterpillars before spinning a cocoon, therefore after the fourth moult, were transformed into moths. He believed it to be only talk, the more so as nobody had published anything about such a case. But he convinced himself of the fact in 1792. Invited purposely to convince himself by his own observation, he saw two boards filled with caterpillars transformed in the preceding night into moths without having spun cocoons, to the regret and deception of the owner. Recently the same fact was observed, and in 1811 he received by Dr. Siboni two such winged deformities, bred by Mrs. Rosatti, and examined by Mr. Farini. These differ from the regularly developed silk-moth in the following characters: The head is small, with two black compound eyes; the thorax similar to the third segment behind the head of the caterpillar, and the abdomen similar to that of a caterpillar at the time of the fourth moult, with just as many segments as the abdomen of the caterpillar; the fore-wings somewhat elongated and narrowed; the hind-wings shorter and narrower; the antennæ grayish, compared with those of the regular silk-moth. Mr. Majoli gives an hypothesis for the cause of such a transformation, and believes it to be the excessive warm temperature of the breeding-room. The caterpillar ready for transformation is prevented by the heat from producing the exudation of the fluids which are necessary for the formation of the chrysalis, and is obliged to transform directly into the moth. To ascertain his hypothesis he should have made experiments to produce such a transformation in an artificial way, by exposing caterpillars shortly before the fourth

moult to a high temperature. It will be of interest to know if the moths possessed well-developed genital parts, fitted for copulation and for the deposition of fertile eggs.

I have given purposely, in full, the original, as the two records existing disagree on some important facts. Lacordaire seems to have seen the original, as his record contains some statements not given by Meckel. Nevertheless, he has surely seen, and partly translated, Meckel's record, as is proved by the words: "les deux yeux noirs rapprochés," a verbal translation of the "Zusammengesetzten Augen," by Meckel. The presence of fore-wings only is recorded by Meckel, of hind-wings only by Lacordaire.

The statements given by Majoli are probable, except that the thorax, which is said to be similar to the third segment of the caterpillar, has four wings. The identity of the abdomen with the abdomen of the caterpillar consists perhaps only in elongation, as the presence of other parts is not mentioned.

Lacordaire considers the fact as proving the development of certain parts of an insect by precocity, though the other parts follow the common rule of development.

The fact would be a rather interesting one if it was beyond doubt. As silk-worms are raised every year by millions, I should have supposed that the observation would have been oftener made and published. Nevertheless, it is astonishing that such a fact, filling in some way the gap between insects with an incomplete metamorphosis, and those with a complete one, is not used by evolutionists.

A paper by the well-known Lepidopterologist, Mr. E. J. C. Esper, in Hoppe, Entom. Taschenbuch (for 1796), pp. 183 – 188, which I have not at hand, may possibly treat the question of a precocious development.

Majoli's observation is briefly reproduced (after Meckel) by Professor Van der Hoeven, in his quoted paper, p. 272. He remarks that no related observations are known, and that his observation rests only upon its own merits.

DEFORMITY OF THE ELYTRA.

Strategus (Geotrupes) Julianus.

The late Professor J. Wyman observed a specimen of this large beetle flying around in Florida in 1874. The movements were in some way strange and unusual, and induced Professor J. Wyman to catch the beetle. To his astonishment he found it perfectly developed, but the elytra wanting. The specimen, preserved in alcohol, he presented shortly before his death to the collection.

The specimen is a female, of thirty-six mm. length, and perfectly developed. The wings are in good and perfect condition, but there is no trace of the elytra; which are entirely wanting on both sides. Professor J. Wyman thought at first that the elytra had been removed by somebody, and the insect put again at liberty But a careful examination of the living insect as well as of the alcoholic specimen by Dr. J. L. Leconte, and by myself, showed no lesion whatsoever in the place where the elytra should have been inserted. The anterior border of the mesothorax is horny and smooth, and near the scutellum exists a small membranous place without any wound. The legs, the prothorax, the upper part of the mesothorax, the metathorax, the scutellum, and the whole abdomen, are perfectly developed.

This case of deformity belongs to the "monstres ectroméliens" of Lacordaire, but as far as I am able to ascertain, no similar case is recorded. The fact that the beetle was able to fly without elytra is of additional interest.

Prionus coriarius.

This remarkable case is twice recorded, but later entirely overlooked. As I believe this kind of deformity of prominent value, I give a translation of the original communication by Dr. Saage in Preussische Provinzial Blaetter (1839), Vol. XXII, p. 191.

"One of my school-boys brought me to-day a male *Prionus coriarius*, the thorax of which presents a curious deformity. The horny dorsal cover of the mesothorax is wanting, and instead of elytra there are inserted, just in their place of articulation, two perfect legs, directed above and behind. The metathorax has the wings as usual, and the abdomen is of the same horny character as commonly, when covered with elytra. In attempts at flight the insect moved, together with the wings, the abnormal dorsal legs. The scutellum is wanting, and the prothorax has only two spines; all other parts are perfectly developed."

"Braunsberg, Prussia, July 10, 1839."

This communication is reprinted in Stett. Ent. Zeit., Vol. I, p. 48. The specimen was seen and examined afterwards by Professor von Siebold.

I have always considered this case to be a striking proof of the homology of the wings with the legs. No similar case has been recorded.

EXPLANATION OF THE PLATE.

FIGS. 1 – 5. — **Morpho Eurylochus.**

Fig. 1, side view. Fig. 2, the head of the same, magnified, showing beneath the separated mentum. Fig. 3, front view of the head. Fig. 4, the same from below, showing the forelegs. Fig. 5, head of the perfect imago.

FIGS. 6 – 9. — **Phalæna heteroclita.**

The figures are copied from the original in the Mémoir. Prés. Acad. Paris, Vol. VI. The plate given by Goeze is not exactly reproduced.

Fig. 6, the moth from above. Fig. 7, the same from below. Fig. 8, front view of the head. Fig. 9, the eggs.

FIGS 10, 11. — **Nymphalis Populi.**

The figures are copied from the Bull. Acad. Bruxelles, Vol. IV.

Fig. 10, the butterfly from above. Fig. 11, front view of the head.

The plate was intended to contain all figures given for this kind of deformity. When it was made, Mr. Bruinsma's paper was not known to me.

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